NOV - 3 1933

Heating · Piping and Air Conditioning

Air Conditioning Aids Making of Largest Telescope Mirror

Interest in Modernizing with Public-Works Funds Increases

Proper Selection of Pressure Regulators

Installation of Traps for Plant Unit Heaters

Journal Section of the A. S. H. V. E.

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GENERAL ELECTRIC

Heating · Piping and Air Conditioning

THE EDITOR'S PAGE

FROM consulting-engineer readers of HEATING, PIPING AND AIR CONDITIONING in every part of the country have come references to actual, specific examples of advantageous modernization of the mechanical services in public and institutional buildings. Striking proof of the soundness of the plan advocating expenditure of part of the $3,300,000,000 appropriated by the government for public works for modernization are these cases from those who are in a position to know where money can be spent *now* to save in the future. Our lead-off article this month tells of the present status of the plan, again urges that action now will clinch its acceptance. With the article are included many of the above-mentioned examples.

The plan itself—with a number of examples—was first presented in the September issue; in October, the method of translating the idea into the appropriation of money was described. This month's article will be equally useful to those who feel that the government will be on the right track in spending money for modernization of mechanical equipment in existing properties.

DESPITE the numerous applications of air conditioning in some two hundred industries, it is doubtful whether many persons would think of it in connection with the making of an astronomical telescope. However, one of the most important undertakings in the field of science today is the construction of the new 200-in. telescope at California Institute of Technology —and air conditioning is playing a most important part.

Controlled temperature and humidity is expected to cut the time required in making the 200-in. mirror from nine years to three years. Just how air conditioning is employed to achieve this advantage is described in M. M. Lawler's article this month (page 547) . . . Air conditioning for comfort has been brought to the attention of millions at the Chicago Fair; more of the installations at the exposition are described this month (page 558) . . . In the Journal Section of the *A.S.H.V.E.* this month is published a paper which is of considerable value and which should not be overlooked; the subject is the heating effect of artificial lighting, a factor to consider in air conditioning.

HOW master control valves save steam at the University of Colorado (suggestive of modernization that could be performed in many classes of buildings) is the subject of an interesting heating article this month. (See page 556) . . . . Chart No. 8 in Price L. Roger's series on calculating heating surface for buildings appears on page 569 . . . A discussion on trapping of unit heaters for industrial-plant heating starts on page 561, will prove helpful to many.

SABIN CROCKER'S series of articles on piping standardization have created a great deal of interest since publication of the first one in the September issue; this month's installment swings into the subject of materials specifications. . . . Another piping article which shouldn't be missed is Harold L. Colby's discussion of pressure regulators, their selection and installation. . . . Another of Emory Kemler's charts for calculating flow and pressure-drop in process piping is shown on page 555. . . . W. H. Wilson tells how time and money is saved by proper supervision of piping maintenance, stresses the importance of having the proper equipment to do piping maintenance work.

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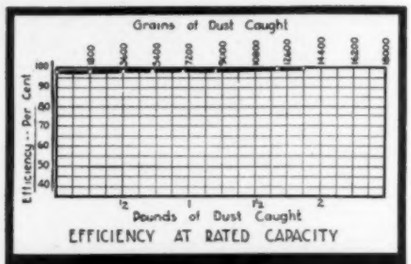

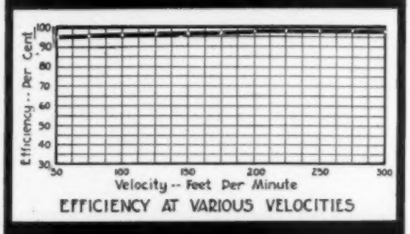

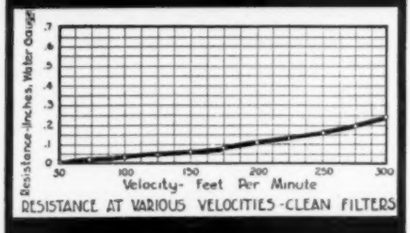

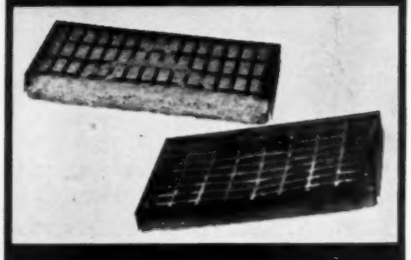

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HEATING, PIPING and AIR CONDITIONING

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Published Monthly by KEENEY PUBLISHING COMPANY 1900 Prairie Avenue, Chicago

F. P. Keeney
President and Treasurer

TERMS OF SUBSCRIPTION

Anywhere in the world, $2.00 per year.
Current copies, 25c each. Back numbers, 50c each.
Member Audit Bureau of Circulations.
Member The Associated Business Papers, Inc.

Address all Correspondence to Chicago Office.

New York Office, Rooms 1705-1706, 110 East 42nd Street.
Cleveland Office, 2047 Rossmoor Road, Cleveland Hts.

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THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

Heating · Piping
and Air Conditioning

Vol. 5, No. 11

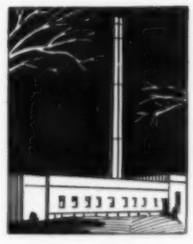
November, 1933

Impetus Given
Public Works Modernization Plan; Proper Effort Now Should Put It Over

THE recently-awakened recognition of the administration of the necessity for reviving the "capital goods" industries in order to restore real prosperity should give increased impetus to the plan presented in our last two issues for expending a portion of the Public Works Appropriation for modernizing mechanical equipment in existing public properties.

Shown here is a telegram sent by General Hugh S. Johnson, administrator of the National Recovery Administration, to a meeting in Chicago of The Associated Business Papers, Inc. It is evidence that the administration is mindful of the need for releasing "the dammed-up demand for machinery and equipment and other goods required by mills and factories and our transportation systems for fully efficient operation under today's conditions."

The government can contribute itself to releasing this demand and insuring the upward trend in business by modernizing the mechanical equipment in its own federal buildings, by stimulating through its Public Works Administration the application for loans from states, counties, municipalities and private agencies for this purpose, and by allotting a portion of its huge fund to employing competent consulting engineers for surveying these public properties in order to line up definite projects in which such modernization would prove sound. As shown before and later in these columns, modernization is sound from the standpoint of being a self-liquidating investment and of creating employment where badly needed.



Up to October 1, 1933, $1,653,631,000 of the $3,300,000,000 Public Works Fund had been allotted. During October additional allotments perhaps brought the total to close to $2,000,000,000. Of these allotments, how-

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TELEGRAM

The Associated Business Papers, Inc.

ON THE OCCASION OF THE SESSION OF THE ASSOCIATED BUSINESS PAPERS, TOGETHER WITH THE NATIONAL CONFERENCE OF BUSINESS PAPER EDITORS, MAY I SUGGEST THAT YOU GIVE EARNEST ATTENTION TO THE SITUATION NOW EXISTING IN CAPITAL GOODS INDUSTRIES. YOUR GROUP IS INFORMED AS TO THE VAST AMOUNT OF PURCHASING OF DURABLE GOODS WHICH HAS BEEN DEFERRED DURING THE PAST THREE YEARS. YOU UNDERSTAND THAT THE INDUSTRIES PRODUCING SUCH GOODS REPRESENT MORE THAN HALF THIS COUNTRY'S NORMAL BUSINESS. WE ARE AT A CRITICAL TIME IN RECOVERY. CONFIDENCE OF THE GREAT MASS OF OUR PEOPLE IN THEIR OWN FUTURE AND IN THE FUTURE OF THE COUNTRY HAS BEEN RESTORED. MEN ARE GOING BACK TO WORK; PAY ENVELOPES ARE FATTER. WE MUST INSURE THIS UPWARD TREND BY MAKING IT PRACTICABLE FOR PURCHASING OF DURABLE GOODS TO BE RESUMED AGAIN, SO THAT THE INDUSTRIES THAT MAKE SUCH GOODS AND THE WORKERS NORMALLY EMPLOYED IN THOSE INDUSTRIES MAY AGAIN HAVE AN INCOME. IT IS WITHIN YOUR PROVINCE TO CONTRIBUTE MIGHTILY TO THE RELEASE OF THE DAMMED-UP DEMAND FOR MACHINERY AND EQUIPMENT AND OTHER GOODS REQUIRED BY MILLS AND FACTORIES AND OUR TRANSPORTATION SYSTEMS FOR FULLY EFFICIENT OPERATION UNDER TODAY'S CONDITIONS. AS YOU HAVE HELPED THE RECOVERY ADMINISTRATION IN ITS EFFORTS TO DATE, YOUR GOVERNMENT NOW ASKS THAT YOU GIVE SPECIAL CONSIDERATION TO WAYS AND MEANS FOR REVIVING THAT PART OF THE NATION'S INDUSTRY THAT IS STILL SICK.

Hugh S. Johnson, *Administrator*
National Recovery Administration

ever, a small proportion has actually been spent, and the demand is for quicker action if it can be gotten without waste. The opportunity for this industry to benefit from this Public Works program is still live, therefore, with more than one billion dollars yet to be allotted and with favorable consideration ready to be given to a suggestion that will produce action.

Several engineering societies, including the *American Society of Heating and Ventilating Engineers,* are pushing in Washington the idea of retaining engineers to make surveys of existing properties, and they are encouraged to believe they are making progress. As we have pointed out before, this modernization is within the scope of the National Industrial Recovery Act; the big need is to line up definite projects and submit them to the Public Works Administration for approval and the necessary loans and grants. Everyone in this industry, therefore, should make his individual effort now to lay before government officials, public works administrators, and engineers reasons for making definite provisions for modernizing existing public properties.

Following are excellent reasons:

CONSULTING ENGINEERS REPORT MODERNIZATION OPPORTUNITIES

1. A survey of a two-hundred bed hospital in the County of Westchester was made to determine if any savings could be made in the operation of its mechanical systems with small expenditures for alterations or additions. It was found that the traps on the heating system and the high-pressure traps for sterilizers, kitchen equipment, etc., were leaking through the returns to the main return tank, and from the tank to the atmosphere. The high-pressure reciprocating boiler-feed pumps were also discharging to the atmosphere with no connection for utilizing the exhaust steam. The condenser water for the refrigerator system was being wasted to the sewer at a temperature of 70 F. The buildings were heated by steam from the high-pressure boilers with only manual control to regulate the temperature of the different rooms. It was also found that the current for power and light was being purchased according to the highest schedule of the service company. By utilizing the exhaust steam for heating water, connecting the refrigerator condenser to discharge into a roof tank, providing automatic control for the pressure-reducing valves, and buying electric current at a wholesale schedule it was found that a saving of $5,500 could be made per year for an expenditure of $7,500.[1]

2. By welding mains to eliminate steam leaks and by properly insulating the high-pressure steam and heating mains in a central-heating plant of a public institution in the upper part of the State of New York, I was able to effect a saving of 350 tons of coal per year. For the same institution I was also able to show that an additional net saving of $12,000 per year could be made by investing $72,000 in new plant equipment. This saving was shown after deducting 10 per cent for interest and depreciation.[1]

3. I revamped a heating system in a large office building in the winter of 1930-31, so that an acceptable service could be rendered to tenants. The cost was $20,000. In addition to giving a satisfactory service we cut the cost of the steam requirements from $7,700 to $5,400, or about 30 per cent.

In 1932 this building was equipped with boilers which were already owned, and stokers were put in them. The cost for this was around $6,000. Last winter the cost of heating dropped to $3,200 or 42 per cent below the cost of heating after the plant had been modernized, and showed a saving of $4,500, or about 62 per cent from the cost of operating the plant before the system had been modernized and the boilers and stokers had been installed.

There are numerous plants throughout the country in which as much or more economy could be obtained, and the buildings made so much more desirable that additional income could be derived from them.[2]

4. A large office building in this city has two 150-horsepower H. R. T. boilers operating at one time. I was asked to make a survey for improvement; some changes in piping connections and increasing the cubical contents of the furnaces. One boiler carried the load easily with a saving of thirty per cent in fuel.

I have just finished a survey of a power plant in which the owners were losing $1,500.00 per year and $1,000.00 would stop this loss.[3]

5. For purely self-liquidating business I should look to going concerns who are large enough and well enough financed to consider the desirability of making added investments for the sake of economy. One very interesting field comprises the plants using large quantities of purchased electricity. Without exception, I believe in these plants some unit or units could be found which could be operated with exhaust-steam turbines, in which case it could be set up that the installation of a privately-owned steam-electric generating plant would be very economical, the turbines providing an exhaust-steam load the year around in addition to the heating load in the winter.

I have recently purchased equipment for a plant of this nature in Los Angeles, the total investment involved amounting to $146,000, which is completely self-liquidating in 3½ years. Their former rate for electricity was 1.2c per kwh, their cost to generate it under the new plan will be 7 mills per kwh. The condition which made this installation possible was primarily the fact that there were three—200-ton rotary refrigerating units, which could be changed to turbine drive. The major portion of the refrigerating load was required for air conditioning work and used only in the warm weather when there was no heating system demand for exhaust steam.[4]

6. An institution in Western Pennsylvania, consisting of eight buildings, had a variety of heating and piping systems within the buildings, fed from a central-heating plant. The major portion of the condensate was wasted, necessitating the use of a large amount of raw make-up water containing many destructive hard-water salts. The total radiation load of these eight buildings approached 30,000 sq ft and the maintenance costs, together with fuel cost, were increasing with each passing year.

After reconditioning the various building systems to an up-to-date vacuum system at a cost of approximately $10,000, the college was able to return all of the condensate to the boilers at a temperature that resulted in a large fuel saving, prolonging the life of the boilers by eliminating the need of added raw make-up water and expense involved in water treatment, and above all increased the heating efficiency throughout the buildings far above that formerly considered possible. Since this reconditioning period, the college has erected another sizable building which added considerable heating load to the already overloaded boilers, yet they were able to go through the last two heating seasons with no apparent difficulties so far as the boiler plant was concerned.[5]

7. Last year we set up a program of modernization for the heating equipment in about thirty-five buildings of one of our leading universities, including heat controls, revamping of the piping, installation of condensation meters, repairs to covering and installation of weather strips, involving a cost of about $50,000 and a saving of $20,000 per year.

If government officials can be shown the wisdom of loaning money for modernization projects, it will open up a vast field for work. I should like to add that this is a kind of work that can be gotten under way quickly and besides effecting a vast amount of economy in the operation of existing plants, it will not involve additional recurring yearly expenditures, such as are caused by the construction of new plants. I might also add that this form of loan would be repaid more quickly than other loans which the government might make on new construction.[6]

8. A very large educational institution called upon me to advise as to how the central boiler plant serving the buildings could be enlarged to provide for additional buildings. A survey showed that the boilers (2,800 hp) were operating at 51 per cent efficiency and below normal rating. At a relatively small cost stokers and other equipment were installed, the efficiency of the boilers was maintained above 70 per cent and ample capacity was made available for the new buildings. An investment of $80,000 proposed was found to be unnecessary and the new buildings were heated without any additional fuel cost.[7]

[1] *C. E. Daniel,* Daniel and Wallen, Consulting Engineers, New York City.
[2] *C. P. Lichty,* C. P. Lichty Engineering Co., Birmingham, Ala.
[3] *Wm. K. Robertson,* Consulting Engineer, Minneapolis, Minn.
[4] *Elliott Lee Ellingwood,* Consulting Engineer, Los Angeles, Calif.
[5] *F. H. Valentine,* Mayer and Valentine, Consulting Engineers, Cleveland, Ohio.
[6] *Perry West,* Consulting Engineer, Newark, N. J.
[7] *Dwight D. Kimball,* Consulting Engineer, New York City.

Air Conditioning Saves Six Years in

Making World's Largest Mirror

Conditioning System for Telescope-Mirror Shop Striking Example of Advantages of Controlled Temperature and Humidity

By **M. M. Lawler***

***A STRIKING** illustration of the way air conditioning is saving time and money in scores of industries (as well as contributing to the health and efficiency of the workers) is the installation for providing controlled temperature and humidity for the shop in which the world's largest telescope mirror is being made. As grinding and polishing is carried out under uniform conditions—and it is possible to test almost at will—it is estimated that air conditioning will reduce the nine years which might otherwise be required for the work to three years . . . . . The difficulties of such a project, and the air-conditioning system which does so much to minimize them, are described here. While the opportunity does not exist for air conditioning to save six years' time in many industries, it is doing an equally good job in numerous plants processing hundreds of products.*

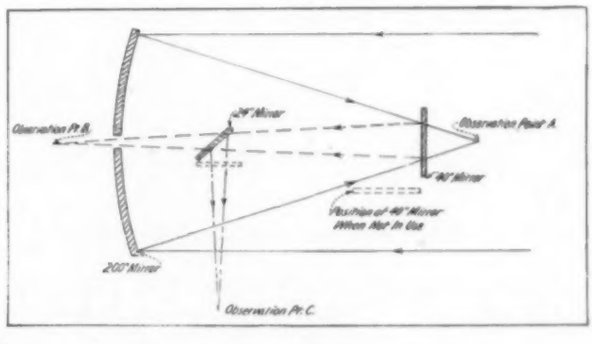
ONE of the most important undertakings in the field of science today is under way on the campus of the California Institute of Technology at Pasadena—the construction of the 200-in. telescope[1] for the new astronomical observatory which, when finished, will be the largest and most complete of its kind in the world. The location of the observatory has not yet been determined, but probably will be somewhere in Southern California because of favorable climatic conditions.

Nearest approach to this in size is the 100-in. mirror in the large telescope at the Mount Wilson observatory, the grinding, polishing and parabolizing of which consumed five years' time. While the difficulties encountered in connection with this work serve as a useful guide to the methods to be used in grinding the 200-in. mirror, yet due to its considerably larger size there are many problems to be solved for which there is no established precedent. Every precaution is being taken to eliminate as many variables as possible and to avoid the occurrence of circumstances that delayed the completion of the Mount Wilson project. How air conditioning[2] is employed in this work is described here.

Mirror Will Weigh 15-25 Tons

Because of its many desirable properties, notably its insensitiveness to changes in atmospheric conditions, fused quartz was first selected as the medium from which to construct the mirror. Attempts were made to build small mirrors of this material, but after considerable experimental work had been carried on with indifferent success it was deemed advisable by the designers to abandon fused quartz as being out of the range of commercial possibility. Pyrex glass was considered the next-best medium and present plans are based on its use. As success has been had in casting a 60-in. disc of Pyrex every indication points to ultimate success with this medium. Although the exact thickness

Fig. 1—Diagram of 200-in. telescope, showing the use of the several mirrors



*District Manager, The Cooling & Air Conditioning Corporation, Los Angeles, Calif.

[1]The telescope will consist of four mirrors; the 200-in., one 40-in. and two 24-in. mirrors, which will provide three observation points. Fig. 1 illustrates the use of the telescope. Light will enter from the heavens as shown and will be reflected to Point *A*, where will be located the observation room in which the ordinary photographic work will be carried on. By swinging the 40-in. mirror into the path of the light it will be reflected back through a hole in the center of the 200-in. mirror to Observation Point *B*, where there will be located a spectograph for use on faint stars. By interposing another mirror in the path of the light from the 40-in mirror it is diverted to Observation Point *C*, where there will be located a spectrograph for use on bright stars.

This 200-in. telescope, having four times the area, will provide four times the light of the 100-in. mirror at Mount Wilson and, as it will reach out into space twice as far, the net effect will be to make available for study eight times as much of the universe heretofore obtainable. It will make it possible to obtain more exact data on heavenly bodies now on the outer range of the Mount Wilson telescope and will also bring within the range of vision many bodies not now available for study.

[2]Consulting Engineers, Hunter and Hudson.

and construction of the disc have not been settled, it will in all probability be of ribbed design not more than 26 or less than 16 in. thick and will weigh between 15 and 25 tons.

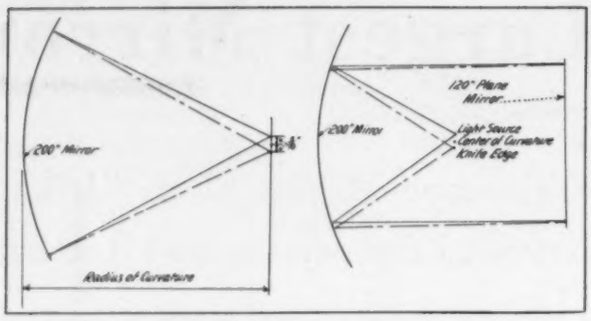


Fig. 2—At the left is the set-up for the spherical surface. Right, test set-up for parabolic surface

As there has never before been a piece of glass of this mass cast it is necessary for the glass manufacturers to develop new processes and new furnaces for this mirror. They also are pioneering in their field and are up against many new problems. For example, it is estimated that the annealing alone will require 1½ to 2 years' time. For this reason they are starting with smaller discs and working up toward the 200-in.

It is interesting to note what might be called the "ratio of desirability" for the different mediums. The designers estimate that Pyrex glass is 25 times better than ordinary glass and that fused quartz is 25 times better than Pyrex glass.

Glass Sensitive to Temperature Changes

Glass is sensitive to changes in the surrounding air temperature, which cause distortion of the glass with resulting deflection of light away from the focal point. It is not possible to eliminate the effects of changing air temperatures at the observatory as the mirror must be open to the heavens to receive light and, consequently, its surface is exposed to the atmosphere. At Mount Wilson an attempt was made to overcome this condition by means of water-jacketing, the temperature of the water being under thermostatic control. Owing to the fact that it was impossible to control the surface temperature of the mirror the distortion was magnified beyond that which would be normally encountered and the water-jacketing was abandoned.

The worst condition is a very sudden change in temperature through a long range, and as this condition is usually accompanied by poor visibility which makes it undesirable to use the telescope, the designers are not particularly concerned about the distortion resulting from the sudden temperature change. Under normal conditions of good visibility the change in temperature is comparatively slow, which allows the entire mass of the mirror to change its temperature uniformly and prevents violent distortion.

Steps in Construction of Mirror

Briefly, the steps to be taken in the construction of the mirror are:

(1) Rough grinding.
(2) Fine grinding and polishing to spherical surface.
(3) Parabolizing or changing the shape of the surface from spherical to parabolic.
(4) Silvering.

It is during the grinding and polishing stage that air conditioning will play an important part.

For grinding the glass a cast-iron tool will probably be used. For polishing, the tool will be a cast-iron or wooden disk faced with resin pitch, the surface of which will be divided into squares and grooved to distribute the polishing rouge uniformly over the surface. As it is not possible to bring the mirror to full polish with the rigid cast-iron grinding tool, the polishing tool must be flexible enough to conform to the curvature of the mirror and not change its shape. During the grinding process, the mirror is mounted in a horizontal position on a spindle which rotates it slowly in order to eliminate possibility of the tool moving through the same path over the surface and so cutting grooves in the mirror.

As the glass is sensitive to temperature, a temperature gradient across the mirror caused by radiation from walls or other sources will distort the glass. If this distorted glass is ground to the desired shape it will be found on testing after temperature conditions have been equalized that instead of having a true parabolic or spherical surface the mirror will return to some other shape. Unless the grinding is carried out under controlled temperature conditions which eliminate this temperature gradient it is impossible to determine on testing whether the apparent distortion is caused by incorrect grinding or by unfavorable atmospheric conditions. A **controlled temperature,** by eliminating this variable, enables the operator to obtain an accurate picture of the effects of his grinding on the mirror and to apply corrective measures with a reasonable assurance that the mirror will retain its surface from day to day.

For rough grinding, the abrasive used is silicon carbide; for fine grinding, aluminum oxide; and for polishing, iron oxide. All of these abrasive materials are applied to the surface mixed with water. While the tool is of the same diameter as the mirror it does not always cover the entire surface. That portion which is exposed is covered with a thin film of rouge which is subject to the atmospheric conditions prevailing in the room, and as these vary so will the consistency of the rouge. It is here that **humidity control** is of the utmost importance for, by controlling the humidity, the amount of evaporation is controlled and the rouge is maintained in a constant condition, permitting continued use of the grinding tool without adjustment to compensate for changing conditions.

Advantage of Controlled Humidity

To illustrate the effect of humidity conditions on the grinding let us compare the results obtained on two successive days after the air-conditioning system was first put in service. The mirror which was being worked on was a 2'-0" disc for the solar furnace. During the first day the relative humidity was maintained at 30 per cent and it was necessary to stop the grinding machine every two minutes and make a fresh application of rouge. Also, because of the rapid rate of evaporation, the rouge collected in a thick paste at the edges

of the mirror, causing the tool to ride on the edges and apply more pressure to this portion of the surface, resulting in an overground edge. During the second day the relative humidity was maintained at 55 per cent and it was possible to operate the grinding machine for twenty-minute intervals before it became necessary to make a fresh application of rouge. At the end of the day it was found that the overgrinding of the edge which occurred on the first day had been almost entirely overcome. As the time required for grinding and polishing is in almost direct ratio to the frequency of application of the rouge it is apparent that proper humidity control saves a tremendous amount of time.

The accuracy of the grinding is tested as shown in Fig. 2. The view at the left shows the test for the spherical surface; at the right, the test of the parabolic surface. In the case of the spherical surface a pin-point of light is projected from a point about $\frac{3}{16}$ of an inch off of the focus of the mirror. If the surface of the mirror is smooth and exactly spherical all of the light will be returned to a point $\frac{3}{16}$-in. to the left of the focus where there is located a knife edge. The image seen in this knife edge will be a disc of light. Should the surface have ridges or depressions in it the light will be deflected off into space away from the knife edge, and the image will show black spots where these ridges or depressions occur.

Importance of Air Conditioning in Testing

Before parabolizing the 200-in. mirror it is necessary to make a 120-in. plane mirror to be used in the test set-up shown at the right in Fig. 2. The use of this mirror doubles the difficulties encountered in testing as compared to the testing of the spherical surface. This testing of the mirrors during grinding is the operation requiring the most accurate control of temperature, air motion and vibration. Radiation from surrounding walls, hot-or cold-air currents set up by wall surfaces of different temperature than the room, and vibration from moving machinery or passing automobiles and trucks, all tend to distort the image of the mirror as seen in the knife edge. As an illustration of the effect of air currents and radiation on the image of the mirror, the heat from a man's body walking in the path of the light beam is sufficient to distort the image due to the deflection of the light in passing through the different density air.

It is planned to set the mirror up for test and operate the air-conditioning system until conditions have been stabilized; that is, that the walls, floor, equipment and mirror will all be at the room-air temperature. Then the equipment will be shut down and the room left undisturbed until there is an absence of air currents, at which time the testing will be carried out. In order to minimize the chance of air currents being set up by the transfer of heat through the walls during the period of shut-down the entire structure has been insulated with 2 in. of cork. The testing will probably be carried out every day, most likely early in the morning in order to eliminate the chance of disturbances from outside affecting the test.

After completion of the grinding the surface of the mirror is coated with a film of silver. Recently, there has been developed at the California Institute of Technology a new method whereby mirrors are coated with aluminum by means of an electrolytic process carried out under a vacuum. As this process appears to offer many advantages over the conventional silvering and there is considerable time available for its development and perfection there is a strong possibility that it may be used on the large mirror.

The Air-Conditioning Requirements

The ideal condition for carrying on the work would be at a temperature of 98-F dry-bulb with a relative humidity of about 50 per cent, as this would eliminate the effects of radiation of heat from the body of the workers. However, as it is impossible to work effectively at such a high temperature it has been necessary to modify this to 77-F dry-bulb and 50 per cent relative humidity, this condition having been selected as the highest temperature that would provide comfort for the workers under the humidity condition which must be maintained for proper grinding.

The building is of concrete and steel construction, insulated with 2-in. cork on all sides. It is divided into two main sections; the 200-in. shop, which consists of one room 54 ft x 160 ft x 39 ft high; and the small shops, containing the 2-ft and the 3-ft grinding rooms, the silvering room, the small test room, the testing tunnel and the general offices and laboratories. There is a 50-ton crane in the 200-in. shop for handling the 200-in. and the 120-in. mirrors and the grinding machine. Across one end of the main shop is a glass-enclosed observation gallery. There are no windows in the building. The installed lighting capacity amounts to four watts per sq ft. The lighting fixtures for the 200-in. shop are located in the attic space and are provided with glass panels in order to reduce the heating effect from the lights. With the type of glass panels used it is estimated that 60 per cent of the heat generated is screened out of the working space.

The design of the air-conditioning system required a very careful analysis of the various heat sources making up the total cooling load, as well as a detailed analysis of the outside weather conditions during the 24-hr period during which the system will be in use. It is quite likely that the load will change from cooling to heating several times during the course of a day, because of the amount of heat liberated by the lights and the power load, as well as the widely varying outside conditions to be encountered during one day's time in Pasadena. To meet these sudden fluctuations of load the type of system shown in Fig. 3 was selected because of its flexibility. In addition, as the usage and load condition of the small shops will not necessarily coincide with that of the main shop, each of these portions of the building is provided with a separate and independent air-conditioning system supplied with cold water from a common refrigerating plant. The diagram in Fig. 3 is typical for both systems.

Operation of Conditioning System

All of the fresh air and part of the return air is passed through the dehumidifier, the balance of the return air passing directly to the fan inlet. The reheaters are located in the bypass duct. The amounts of dehumidified air and bypassed air are varied to suit the load conditions by means of Dampers *1* and *2*, the positions of which are governed by a dry-bulb thermostat located in the main return duct. This thermostat also controls the

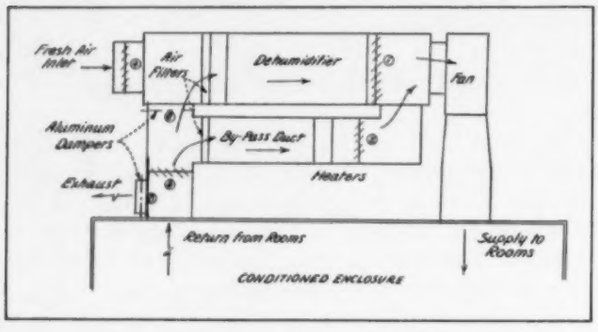


Fig. 3—Diagram typical of both the air conditioning systems

supply of steam to the reheaters, raising or lowering the temperature of the air supplied by the fan to suit the requirements. Dampers *3* and *4* are controlled by a wet-bulb thermostat during the cooling period which is set to furnish fresh air to the system during those periods when the total heat in the outside air is less than the total heat in the return air or when the outside wet-bulb is lower than the inside wet-bulb. This arrangement results in a considerable saving in operating cost by reducing the requirements for refrigeration. During the winter season these dampers are under the control of the dew-point thermostat. As the amount of fresh air supplied to the system is increased the air pressure in the building is increased. This increase in air pressure opens the aluminum Damper *5*, exhausting from the building an amount of air equal to that entering at the fresh-air intake. Damper *6* is an aluminum damper which serves as a check valve to prevent fresh air by-passing the dehumidifier. By the use of this system a constant volume of air is handled by the fan at all times.

Air filters of the cell type, using a wool-felt filter medium, are installed to remove the dirt from all of the air supplied to the building.

Fig. 4 shows part of the equipment serving the small shops. At the left in the foreground is the bank of filters in the bypass duct. At the right foreground are the aluminum check dampers that prevent the flow of fresh air through the bypass duct. In the center is the dehumidifier with the cold-water supply coming up through the floor. In the lower right-hand corner of the dehumidifier tank is the fresh water make-up, quick-filling connection and hose connection for flushing out the tank. Thermometers are provided at various points in the systems for checking the operation of the equipment.

In the 200-in. shop, the air is supplied at a velocity of 600 fpm through a row of outlets along one side wall close to the ceiling and is exhausted near the floor line on the same wall. Smoke tests show a distribution as illustrated in Fig. 5. The air flows across the room close to the ceiling, drops down the opposite side walls and flows back across the room at a velocity of 10 fpm through a zone extending about 15 ft above the floor. There is no tendency for the air to "spill" over the edge of the outlet during the cooling season nor to cling to the ceiling during the heating period. The air is supplied to the small shops and offices through grilles located on the side wall 7 ft above the floor line. The return is taken back at the floor line on the same side of the room.

Electric Heaters Supply Auxiliary Heat

As the systems are to operate 24 hours per day and steam is not available from the main steam plant on the campus during this entire period, auxiliary electric heaters have been installed that will take care of the heating requirements. In the main shop system, the electric heaters are located in the bypass duct in one bank made up of four separate groups. When the steam pressure

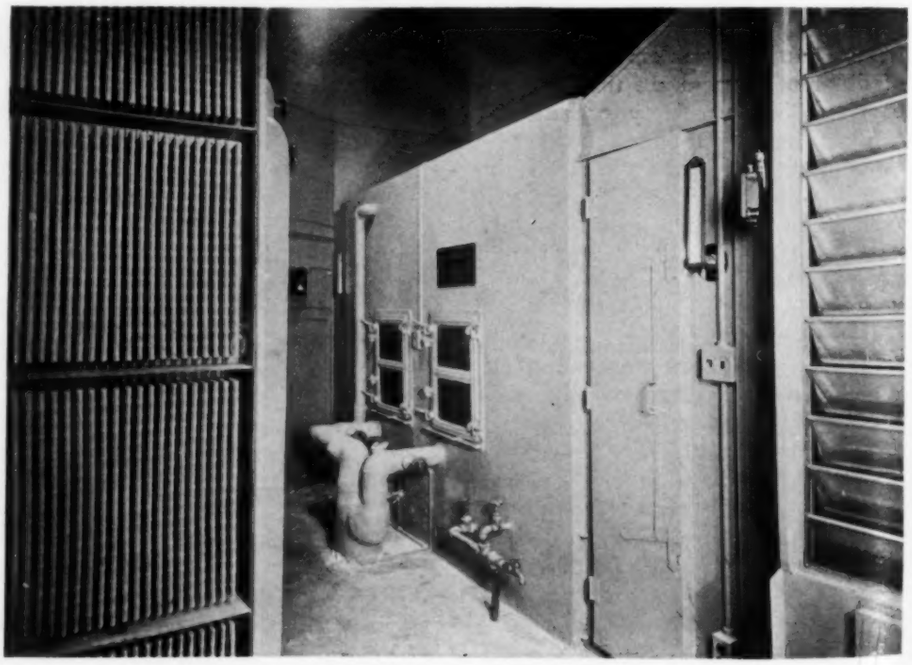


Fig. 4—Part of the air-conditioning equipment serving the small shops. At the right are the aluminum check dampers that prevent flow of fresh air through the bypass duct. In the center is the dehumidifier with the cold-water supply coming up through the floor

on the main line drops, a pressure-actuated mercury switch throws on the electric-heater groups. These heaters are controlled by the previously-mentioned four-point thermostat through air-operated pressure switches. In the small-shops system each room is equipped with its own electric heater located in the air-supply duct and controlled by individual electric room thermostats. These electric heaters in the small shops also serve to take the place of the light and process load in the summer and so maintain the room temperature constant when the heat load in the rooms is dropped suddenly.

60-Ton Refrigeration Plant Cools Water

The two air-conditioning systems are supplied with cold water from a 60-ton refrigerating plant in the basement of an adjacent building. The water cooler is of the shell-and-tube design of the flooded type and is provided with two water passes, one for each air-conditioning system. As the dehumidifiers are located on different floor levels and it was desired to use a closed water circuit to keep down the pumping head, each system has its own cold-water pump located in the machine room. In each cold-water system there is an automatic bypass valve which regulates the flow of water through the cooler, adjusting the temperatures of the water supply to the spray nozzles to suit the load conditions. This bypass valve is controlled by the dew-point thermostat.

The refrigerating compressor used on this job is of the rotary displacement type, consisting of two herring-bone gears which compress the methyl chloride gas used in the system. The clearance space between the ends of the gears and the end housing, and between the gear teeth and the gear housing, is sealed with glycerine which first flows into the ball bearings where it serves as a lubricant. The glycerine passes out of the compressor with the methyl chloride gas and flows to the condenser where it is separated from the methyl chloride, cooled and returned to the compressor.

The compressor is driven by a 75-hp, 1000-rpm, slip-ring motor. The capacity of the plant is varied to suit the load by means of automatic speed control of the compressor motor. The motor is arranged for 70-per cent speed reduction and as the capacity of the compressor varies directly as the speed for any given set of pressure conditions, it is possible to obtain a range of capacities from 18 to 60 tons. The speed of the compressor is governed by an electric thermostat immersed in the methyl-chloride liquid in the water cooler, operating through a motor-driven drum switch. If the compressor is running at a constant speed a reduction in load will tend to reduce the suction pressure and the liquid temperature. The liquid thermostat will then operate to reduce the speed until the capacity and the load are balanced. Pilot switches and relays have been provided in the electric circuit to prevent "hunting." Fig. 6 shows the machine room and illustrates the relative positions of the various pieces of equipment.

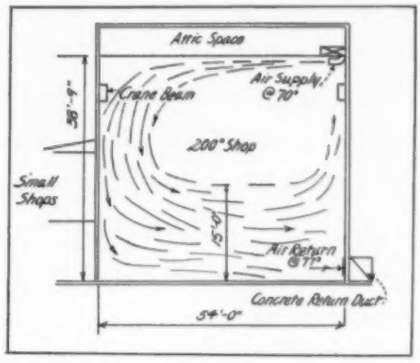
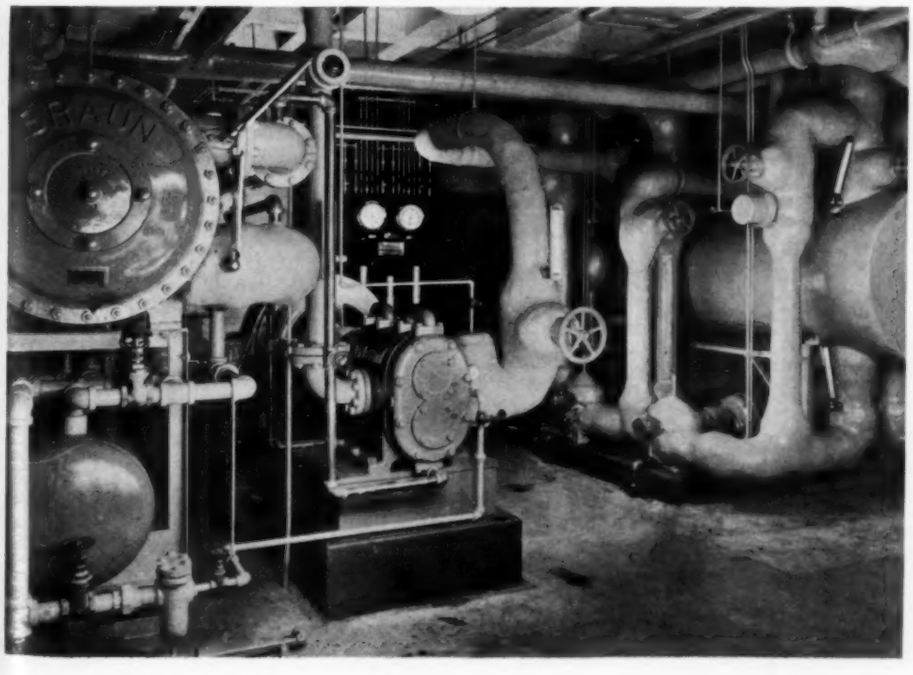


Fig. 5—Air distribution as indicated by smoke tests

The condenser-water cooling system consists of a spray pond located on the roof of the optical building and a 1000-gallon storage tank in the attic space under the roof to receive the run-off from the pond.



Insulation of Piping, Ducts, and Housings

All cold-water piping and low-temperature gas piping is insulated with 1-in. of hair felt. All ducts, fan and housings in the attic space over the 200-in. shop are insulated with 1-in. of corkboard, and the dehumidifiers are insulated with 2 in. of corkboard. All steam and return lines in the optical building are insulated with double-thickness magnesia covering to reduce the amount of heat transferred from the steam to the air in the building.

Fig. 6—The machine room, showing the heat exchangers, control equipment, compressor, motor, etc.

Piping Standardization..... Materials Specifications

THE STORY of national standardization of piping swings into a discussion of materials specifications this month; the two previous articles in this series have dealt with dimensional standards. Materials specifications will also be the subject of the next installment.....The author, Sabin Crocker,* has been actively identified with piping standardization work for the past ten years, is well qualified to discuss and interpret this subject.

THE two previous articles in this series (published in the September and October issues) dealt with dimensional piping standards; the present article concerns specifications for materials used in connection with those standards. Neither dimensional standards nor material specifications would be sufficient independently, since the adequacy of either depends on what is used for the other. Hence, when *A.S.A.* Sectional Committee *B-16* first undertook the formulation of dimensions for steel flanged fittings and companion flanges for a series of pressure ratings at a maximum temperature of 750 F, it was immediately recognized that flange dimensions, bolting, body-wall thickness and the like must be predicated on materials of established physical properties and chemical stability. The consensus of opinion was to the effect that such specifications could be drafted to best advantage by the *American Society for Testing Materials,* and accordingly an invitation was extended to that Society to undertake their preparation.

Establishing a Standard

Under *A.S.T.M.* procedure the personnel of committees and subcommittees charged with the execution of various projects of a commercial nature is approximately equally divided between representatives of producers and non-producers. The non-producing group includes both consumers and general interests, of which the latter contains representatives of testing laboratories, consultants, educators, and government bureaus. This diversity of membership tends toward securing adequate consideration of commercial problems from economic and practical, as well as technical, angles. Due to balanced membership the views of neither group are allowed to predominate unduly, and controversial points usually are compromised on a mutually satisfactory basis. In any event, since approval by two-thirds of those voting is required under *A.S.T.M.* procedure to adopt or amend a specification, the results usually are quite generally satisfactory. Careful consideration is accorded every negative vote and an effort usually is made to reconcile those opposing a proposition even after two-thirds of those voting have approved it.

In the case of Subcommittee *XXII* of *A.S.T.M.* Committee *A1,* which is responsible for the preparation of specifications for piping for high-temperature service, membership is distributed between: several manufacturers of pipe, valves, fittings, flanges and bolts; representatives of consuming interests including the power industry, oil refineries, and piping fabricators who may be both producers and consumers in assembling the finished product; and general interests, including research and testing laboratories. As a result of the variety of interests constituting such committees and the thorough discussion which occurs in reaching agreement on debatable points, the specifications usually are well seasoned before they are published even as "tentative."

A.S.T.M. Specifications and Their Application to Service

The specifications for piping materials of the *American Society for Testing Materials* embrace a wider variety of products and are in more general use than those of any other specification-writing body. This situation has been recognized in the *A.S.M.E.* Boiler Construction Code and in the proposed *A.S.A.* Code for Pressure Piping, both of which employ *A.S.T.M.* specifications for piping materials almost exclusively. The following *A.S.T.M.* specifications relating directly to piping are in existence; additional specifications applying to alloy steels suitable for service temperatures up to 1100 F are in preparation. *A.S.T.M.* designation numbers with a "T" suffixed denote "Tentative Specifications," those without the "T" are "Standard Specifications." The final number, as for instance "33," refers to the year of issue of the latest revision, which in this case is "1933."

BOLTING: Alloy Steel Bolting Material for High-Temperature, Service[3], *A.S.T.M. Designation A96-33.* Chemical composition, heat treatment, physical requirements, and tests for three classes of rolled, forged or cold-drawn bars suitable for bolts and

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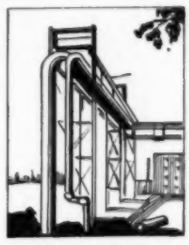
studs; and chemical compositions for two classes of material suitable for nuts. Semi-finished nuts of American Standard Heavy Series dimensions are specified, and American National Standard Coarse Screw Thread dimensions, with no less than eight threads per inch. Bolting material in accordance with this specification is recommended for use with carbon-steel castings for high temperature service in the American Standard for Steel Flanged Fittings and Companion Flanges. While carbon-steel bolts and studs may be specified to withstand the stresses encountered for moderate temperature service, the steel flanged fitting standard recommends the material specified in *A96* for maximum service conditions.

CASTINGS: Under this heading are grouped the two specifications for cast-steel and cast-iron pipe flanges and fittings, and valve bodies. The specifications for cast-iron hub-and-spigot pipe and special castings are listed under *Pipe.*



Carbon Steel Castings for Valves, Flanges and Fittings for High-Temperature Service,[1] *A.S.T.M. Designation A93-33.* Chemical composition; heat treatment; physical requirements and tests; hydrostatic tests; workmanship and finish; and repairing defects for carbon cast-steel flanges, fittings, and valve bodies. These castings cover a high-grade product suitable for use at temperatures at least up to 850 F. Where the expected useful life is only five years or so and periodic inspection is provided as in the oil industry, carbon steel castings in accordance with this specification have been used satisfactorily at temperatures considerably above 850 F.

Cast-iron Castings for Valves, Flanges and Pipe Fittings, A.S.T.M. Designation A126-30. Method of manufacture; chemical composition; physical properties and tests for (*a*) regular gray iron, (*b*) higher strength gray iron; dimensions of standard test specimen; workmanship and finish; certification of tests where product is manufactured in advance and supplied from stock by the manufacturer, jobber, or other dealer.

FORGINGS: Forged or Rolled Steel Pipe Flanges for High-Temperature Service[1]*, A.S.T.M. Designation A105-33.* Chemical composition; heat treatment; physical requirements, and tests for three classes of flange material. *Class A* material is intended for forge welding; *Class B* is acceptable for companion flanges with hubs and is recommended for fusion welding; *Class C* should be used for companion flanges when made without hubs.

PIPE: Numerous *A.S.T.M.* specifications are available for pipe made of a variety of materials and intended for a wide range of service conditions. These specifications are reviewed individually below, followed by collective comment regarding where the various products are commonly used.

Lap-welded and Seamless Steel Pipe for High-Temperature Service[1]*, A.S.T.M. Designation A106-33T.* Chemical composition; manufacture; physical properties, and tests; hydrostatic tests; workmanship and finish; lengths and permissible variations for one grade of open-hearth lap-welded steel pipe, and three grades of seamless pipe made of open-hearth or electric-furnace steel. This specification differs from its predecessor, *A106-29,* in the provision for supplementary requirements of an optional nature which can be applied if desired in the purchase of "seamless pipe for use in central stations at pressures of 400 lb per sq inch or over, and temperatures of 750 F, or elsewhere when a superior grade of pipe is required." The specification also contains a revised table of dimensions and weights for pipe for working steam pressure ratings of 250, 300, 400, 600, 900 and 1500 lb per sq inch.

Welded and Seamless Steel Pipe, A.S.T.M. Designation A53-33. Chemical composition; manufacture; physical properties and tests; hydrostatic tests; threading; workmanship and finish; lengths; permissible variations; and tables of dimensions and weights for standard-weight, extra-strong, and double-extra-strong bessemer and open-hearth furnace-welded pipe, and low and medium-carbon open-hearth seamless pipe. Dimensions for standard-weight and extra-strong pipe are given in nominal sizes ⅛ to 12 inches inclusive, and for double-extra-strong in sizes ½ to 8 inches inclusive.

Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, A.S.T.M. Designation A120-33T. Hydrostatic tests; lengths; threading; workmanship and finish; galvanizing requirements; and tables of dimensions and weights; for standard-weight, extra-strong, and double-extra-strong pipe for ordinary uses. The size range covered is identical with that of *A53,* although *A120* pipe is made and stocked principally in the small diameters. Chemical composition and physical requirements are not included. According to the scope this product is intended for ordinary uses where severe pressures and/or temperatures are not involved.

Welded Wrought-Iron Pipe, A.S.T.M. Designation A72-33. Manufacture; physical properties and tests; hydrostatic tests; threading; workmanship and finish; lengths; permissible variations; and tables of dimensions and weights for standard-weight and extra-strong wrought-iron pipe.

Electric-Fusion-Welded Steel Pipe, Sizes 30 inches and Over, A.S.T.M. Designation A134-32T. Requirements for plate material; manufacture; physical requirements and tests for specimens taken across the weld; hydrostatic tests; permissible variations; workmanship and finish; repairing defects; protective coatings where required.

Electric-Fusion-Welded Steel Pipe, Sizes 8 Inch But Not Including 30 inch, A.S.T.M. Serial Designation A139-32T. The scope of these specifications is similar to that of *A134-32T,* but the requirements are given in more detail and are somewhat more rigorous. Physical requirements are covered for two grades of pipe and marking of the product is included.

Electric-Resistance-Welded Steel Pipe, A.S.T.M. Designation A135-32T. According to the scope this product is intended for conveying liquid, gas or vapor at temperatures below 450 F, and is adapted for flanging and bending in the smaller sizes. At present, resistance welded pipe is made in nominal sizes of 2 to 16 inches inclusive. Chemical composition; physical properties and tests; hydrostatic tests; permissible variations; lengths; workmanship and finish; repairing defects; marking. Physical requirements are covered for two grades of pipe.

Forge-Welded Steel Pipe, A.S.T.M. Designation A136-32T. Requirements for plate material; manufacture; chemical composition; physical properties and tests; hydrostatic tests; permissible variations; lengths; workmanship and finish; repairing defects; marking. Physical requirements are covered for two grades of pipe.

Lock-Bar Steel Pipe, A.S.T.M. Designation A137-32T. Requirements for plate material; method of manufacture; chemical composition; physical requirements and tests; methods of end attachment; hydrostatic tests; permissible variations; objectionable defects; and protective coating for pipe made up with a lock-bar longitudinal seam.

Riveted Steel and Wrought-Iron Pipe, A.S.T.M. Designation A138-32T. Requirements for plate material; method of manufacture; lengths; hydrostatic tests; and protective coating for pipe made up with a riveted longitudinal seam.

Copper Pipe, Standard Sizes, A.S.T.M. Designation B42-33.

[1]These specifications contain an explanatory note reading, "This contemplates temperatures from 500 to 850 F. Allowable pressures and their corresponding allowable temperatures are given in the following table. (Similar to Table 1 shown on page 457 of the September, 1933, H.P.A.C.—*Editor.*) Higher temperatures with appropriate pressures may be used at the discretion of the designing engineer. Reference may be made to the dimensional standards for pressures and temperatures formulated by the Sectional Committee on Standardization of Pipe Flanges and Fittings, under the procedure of the *American Standards Association, A.S.A. Project No. B16, etc.*" The explanatory note for *Specification A106-33T for Lap-welded and Seamless Steel Pipe for High-Temperature Service* differs in detail but not in significance from the foregoing, and refers to *A.S.A. Sectional Committee B36* rather than *B16.*

Chemical composition; physical properties and tests; hydrostatic tests; standard dimensions and weights for standard and extra-strong schedules; permissible variations; workmanship and finish. According to the scope this product is suitable for use in plumbing, boiler, boiler feed lines, etc.

Brass Pipe, Standard Sizes, A.S.T.M. Designation B43-33. Chemical composition for hot-pierced and cold-processes; physical requirements and tests; hydrostatic tests; standard dimensions and weights for standard and extra-strong schedules; permissible variations; workmanship and finish; annealing. According to the scope this product is suitable for use in plumbing, boiler-feed lines, etc.

Cast-Iron Pipe and Special Castings, A.S.T.M. Designation A44-04. Standard dimensions and weights for hub-and-spigot pipe and fittings; method of manufacture; marking; physical properties and tests; hydrostatic tests; permissible variations; coating. Four weights of pipe are provided and several weights of fittings. This product is similar to that covered by *A.W.W.A.* Standard Specifications for Cast-Iron Water Pipe and Fittings described in next month's article.

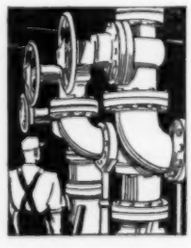
Cast-Iron Soil Pipe and Fittings, A.S.T.M. Designation A74-29. Standard dimensions and weights of hub-and-spigot soil pipe and fittings; chemical composition; physical properties and tests; permissible variations; workmanship and finish; marking; coating.

Application of Various Specifications

In general, the application of various piping specifications has been indicated in the foregoing descriptions. With steel pipe, however, the number of *A.S.T.M.* specifications in existence indicates the need for some further explanation of where certain varieties of the product should be applied.

Specification A120 covers the ordinary variety of furnace-welded and seamless steel pipe kept in jobbers' stock for plumbing and heating, and low-pressure, low-temperature power and process work. Since no physical or chemical requirements are provided, assurance that this pipe is sound depends on the integrity of the manufacturer and the fact that it is subjected to a hydrostatic test several times the probable working pressure.

Specifications A53 and *A135* cover products of about equal quality suitable for flanging and bending, and which are generally used at temperatures up to 450 F and pressures not in excess of 400 lb. The material and tests prescribed are intended to insure satisfactory quality for such service. For higher pressures and temperatures up to 850 F, *Specification A106* is available. The supplementary requirements of *A106-33T*, which are of an optional nature and apply only when agreed between vendor and purchaser, provide additional tests made on each length of pipe to insure obtaining uniformly sound pipe for unusually severe service conditions. These tests are intended to locate and reject the occasional unsound lengths of pipe which might otherwise slip through where tests are made on only a few lengths from each lot.



Specifications A134, A136, A137, A138, and *A139* cover large-size steel pipe, large tonnages of which are used for underground gas, oil, and water lines, especially of the cross-country variety. These varieties of pipe are used also to a certain extent around oil refineries, gas works, hydraulic plants, and water-pumping stations. Decision as to which kind to use hinges mainly on relative cost, which may change from time to time. For low-pressure underground work the question of durability as well as cost enters into making a choice between wrought-iron or cast-iron pipe and the numerous types of steel pipe available. Underground pipe usually is given some form of protective coating, and large-size water pipe sometimes is protected inside with a cement lining.

Specifications A134 and *A139* for two size-ranges of electric-fusion-welded pipe cover a product intended primarily for applications mentioned in the preceding paragraph, under which conditions many thousand miles of this pipe are in successful use. Where, however, electric-fusion-welded pipe is intended for severe service conditions, such—for instance—as those under which *A106* pipe is commonly used, it should be made and inspected under more rigorous requirements. At the present time it is thought that these requirements should be equal to those of the *A.S.M.E.* Boiler Code for *Class 1* fusion-welded pressure vessels, including stress relieving and X-ray examination of the welded seam. The *A.S.T.M.* has such a specification in course of preparation.

[A second article on materials specifications (the fourth of the series) will be published next month. It will cover piping specifications other than *A.S.T.M.*, pipe for fusion welding, piping materials for service at temperatures up to 1100 F, and will include a table showing typical properties of several alloy-steel piping materials for operating temperatures above 750 F—*Editor.*]

FLOW AND PRESSURE-DROP Calculations for Process Piping

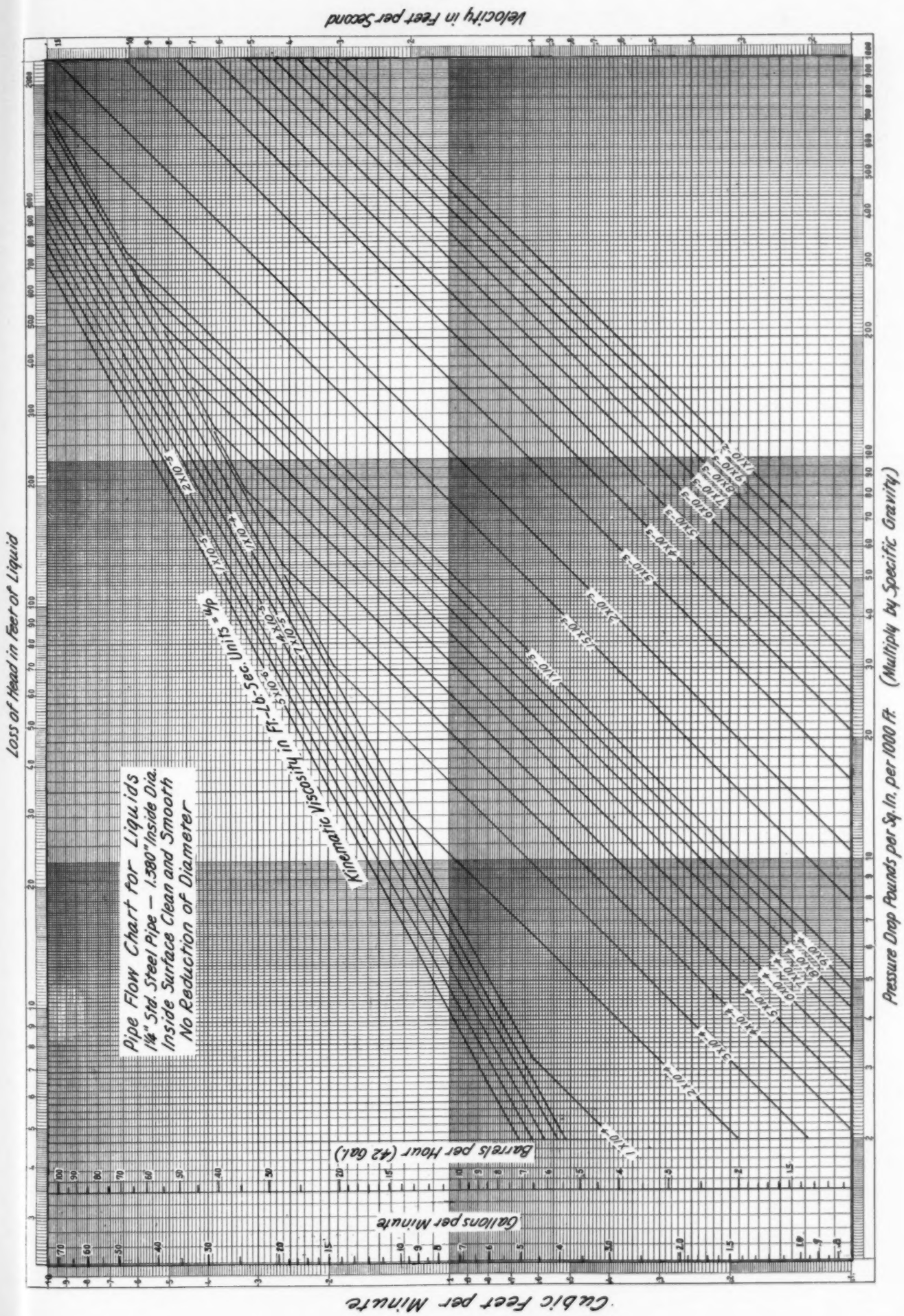
By **Emory Kemler***

ON THE opposite page is a chart designed to facilitate the making of pressure-drop calculations for liquids of various kinematic viscosities flowing in 1¼-in. pipe. The complete series is planned to cover standard pipe sizes from ¼ to 4 in., the viscosities being chosen to cover a range that will take care of any ordinary process fluid that is being piped.

The first two charts to be published appeared in the October, 1933, issue and were for 1-in. and 2-in. sizes. An explanation of the charts and an example of their use also was published in October, as was a conversion chart for kinematic viscosity and viscosity in Saybolt seconds. Allowing for roughening and accumulations and turbulent flow were also discussed.

This explanatory material in the October issue should be referred to in connection with use of the chart published this month.

*University of Pittsburgh, Pittsburgh, Pa.


Velocity in Feet per Second
Loss of Head in Feet of Liquid
Pipe Flow Chart for Liquids
1¼" Std. Steel Pipe — 1.380" Inside Dia.
Inside Surface Clean and Smooth
No Reduction of Diameter
Kinematic Viscosity in Ft.-Lb.-Sec. Units = ν/ρ
Pressure Drop Pounds per Sq. In. per 1000 Ft. (Multiply by Specific Gravity)
Barrels per Hour (42 Gal.)
Gallons per Minute
Cubic Feet per Minute

At University of Colorado—

Master Control Valves Save Steam

By **W. E. Brockway* and George S. Dobbins†**

IN order to determine the savings possible in steam consumption in certain of the older buildings at the University of Colorado, through the installation of thermostatically-controlled motorized valves on the main steam supply lines to the buildings, the following investigation was undertaken by one of the authors (G. S. D.) as thesis work. The necessary equipment was furnished and installed by the buildings and grounds department. The Supervising Engineer cooperated in the selection of buildings to be investigated and the determination of methods of procedure. The methods used represent no departure from usual practice.

Left—View of northeast corner, Engineering Building No. 2. . . . Center—Woodbury Hall, south side. . . . Right—Southwest corner, Engineering Building No. 1. Building faces north. Steam plant stack in background

The objective sought was an actual comparison under ordinary operating conditions of the amount of steam required to heat a building in the way it had been done in the past, and the amount required to heat the same building equipped with a motorized valve on the main steam supply, actuated by one thermostat located at an advantageous point within the building.

Plan of the Tests

The plan was as follows: A condensate meter was installed in the return line leaving the building to be tested, and records kept of the pounds of steam condensed each day for a period of several weeks before the installation of the master control equipment. Temperatures existing in the various rooms of the building during this period were taken several times each day by means of ordinary thermometers. During this period there was no interruption of the usual hand control of valves as was normally practiced by the heat inspector, janitor, and occupants. Outside temperatures, from which the degree days were calculated, were taken from the records of the U. S. Weather Bureau station on the campus.

After securing records of steam consumption for several weeks in this way, the motorized valves were installed in the main supply line entering the buildings to be tested, and the thermostat put into operation. Readings of the condensate meter and the thermometers in the rooms were continued for the period of the test. A graphic record of the operation of the control valve was obtained with a recording thermometer, the bulb being inserted in the steam main on the building side of the control valve. Thus, the exact time of each opening and closing of the valve was shown on the chart.

All buildings on the campus are heated from the central heating plant. Two of the buildings tested were equipped with the vacuum type of gravity one-pipe system (Paul system). The third building was equipped with the ordinary two-pipe vacuum return line system. No meters for measuring steam consumption had been in use on any of these buildings before these tests began.

The test period extended from November 7, 1932, to April 30, 1933.

Description of Equipment: The equipment consisted of one electric clock thermostat arranged to maintain any desired night temperature and any desired day temperature. It was also arranged with a week-end shut-off which carried the Saturday-night temperature setting through to Monday morning. The motorized valve was operated automatically by means of an electric motor controlled by the thermostat.

Results of the Tests

It has been found by experience that the variation in heat demand and in fuel consumption follows very closely the variation in degree days.[1] Use was made of this fact in interpreting data taken during the test period.

*Supervising Engineer, University of Colorado, Boulder.
†Instructor in Mechanical Engineering, University of Colorado.

[1]A degree day is a unit which is the difference between 65 F and the daily mean temperature when the latter is below 65 F—*A. S. H. V. E. Guide*. Thus, if the daily mean temperature were 64 F, there would be one degree day; if 63 F, two degree days, etc.

Since a reduction of the steam output of the heating plant will not decrease the overhead expenses to any extent, only the cost of coal was taken into consideration in figuring the cost of producing steam. The actual seasonal average cost of the coal used in producing 1000 pounds of steam in the heating plant is 18 cents. All savings are calculated on that basis. Other savings effected in the operation of the heating plant by a reduction in steam output, such as the cost of make-up water and the wear on coal-handling, ash-handling, and other equipment are not taken into consideration.

Complete data showing each day's operation are available, but summaries only are given here of data before and after installation of the thermostatically-operated motorized valve.

Engineering Building No. 2: This, the first to be tested, is a brick building 90x160 ft containing 342,000 cu ft. It is arranged in four sections, each section being 90x40. The front section is two stories high, the second story containing offices and class rooms; the remainder of the building is one story of saw-tooth roof construction. All of the first floor is occupied by the mechanical engineering shops. All outside walls are of brick. The roof is wood, carried on steel trusses. There is no basement.

The building is heated by means of 5,000 sq ft of ordinary cast-iron radiation and is equipped with the vacuum type gravity one-pipe (Paul) system. Supply main is 3 in.

Test period	Before Installing Valve Nov. 7-28	After Installing Nov. 28-Dec. 22
Total steam condensed, lb	163,400	174,970
Total number of degree days	451	935
Pounds steam condensed per degree day	362	187
Estimated seasonal demand based upon 10-year average of 5880 degree days, lb of steam	2,128,500	1,099,600
Estimated seasonal cost of coal based on 18c per 1000 lb of steam	$383	$198
Estimated seasonal saving		$185
Estimated seasonal saving per 1000 sq ft of radiation		$ 37
Remarks on heating conditions	Rooms generally overheated	Rooms comfortable

Woodbury Hall: The second building tested is a compact four-story stone building 36½x81½ ft with a cubage of 117,500 cu ft. The entire building is devoted to class rooms and offices. It is heated by means of 2,250 sq ft of ordinary cast-iron radiation, and equipped with the vacuum type gravity one-pipe (Paul) system. Supply main is 3 in. There is a basement under part of the building.

Test period	Before Installing Valve Dec. 22-Jan. 23	After Installing Jan. 24-Mar. 17
Total steam condensed, lb	153,840	194,150
Total number of degree days	842	1,650
Pounds steam condensed per degree day	183	118
Estimated seasonal demand based upon 10-year average of 5880 degree days, lb of steam	1,076,000	693,840
Estimated seasonal cost of coal based upon 18c per 1000 lb of steam	$194	$125
Estimated seasonal saving		$ 69
Estimated seasonal saving per 1000 sq ft of radiation		$30.70
Remarks on heating conditions	Rooms generally overheated	Rooms comfortable

Engineering Building No. 1: The third building is a brick building 134x163 ft, containing 556,300 cu ft. It is arranged in four sections, each section 134x40½. The front section is two stories high, both the first and second floors being occupied by offices and class rooms. The remainder of the building is one story, of saw-tooth roof construction. The engineering library occupies half of one of the one-story sections. The remainder of the building is occupied by civil and electrical engineering shops. There is a basement under part of the building. The building is heated by means of 8,273 sq ft of ordinary cast-iron radiation and equipped with a two-pipe vacuum return line system. Supply main is 5 in.

Test period	Before Installing Valve Feb. 25-Mar. 25	After Installing Mar. 26-Apr. 30
Total steam condensed, lb	279,920	230,380
Total number of degree days	641	697
Pounds steam condensed per degree day	437	330
Estimated seasonal demand based upon 10-year average of 5880 degree days, lb of steam	2,570,000	1,940,000
Estimated seasonal cost of coal based upon 18c per 1000 lb of steam	$462	$349
Estimated seasonal saving		$113
Estimated seasonal saving per 1000 sq ft of radiation		$13.60
Remarks on heating conditions	Rooms generally overheated	Rooms comfortable

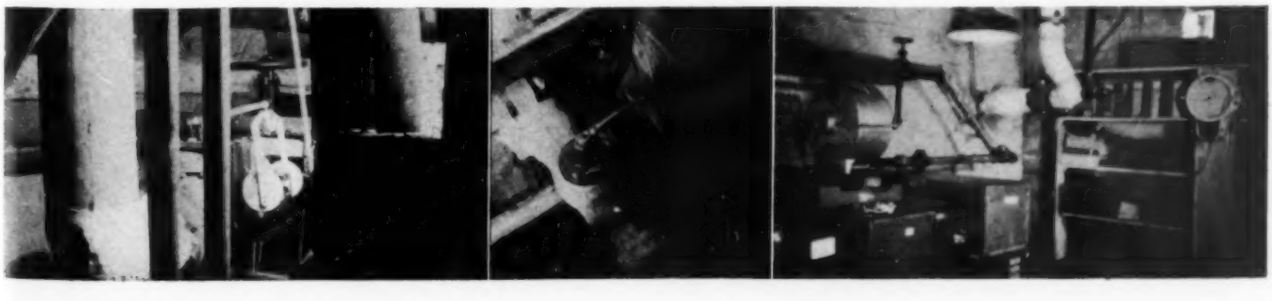
Conclusions Based on Tests

The following conclusions are supported by the test results:

1. The total steam condensed during the heating season may be reduced by some form of automatic heat regulation.

[Turn back to page 73]

Left—Motorized valve in Engineering Building No. 1, 5-in. main. . . . Center—Motorized steam valve in Engineering Building No. 2, 3-in. main. . . . Right—Motorized valve and test equipment in Woodbury Hall. Recording thermometer to right, valve in 3-in. main in center, condensate meter on left



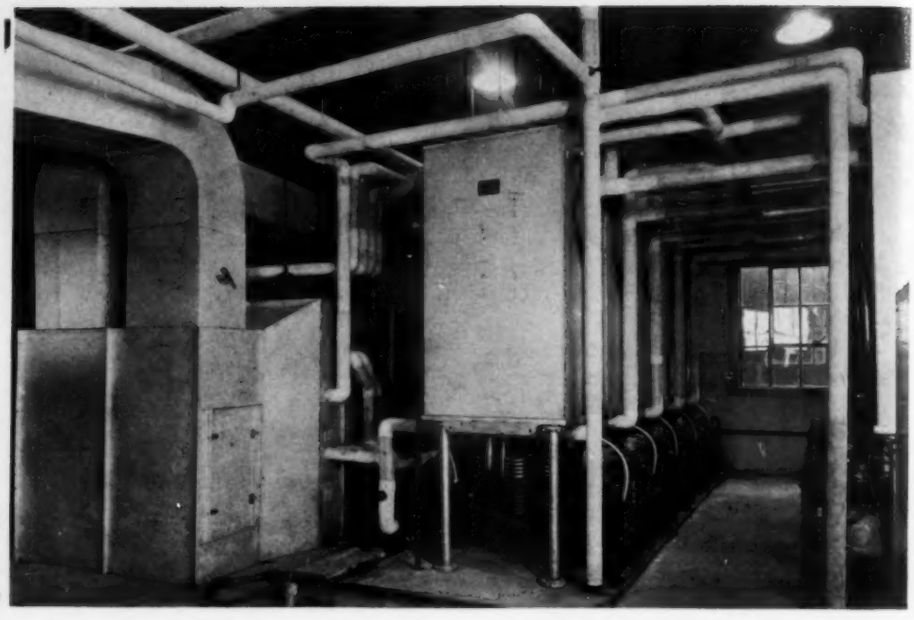


Fig. 1—With this battery of small air-conditioning units, the "House of Magic" (little theater) has been kept comfortable. Ten compressor units, installed for test purposes, provide a total of 25 tons of refrigeration

Millions Have Experienced

Air Conditioning at the Chicago Fair

EXHIBITS at the World's Columbian Exposition, the 1893 Chicago Fair, did much to bring cold storage to the attention of the general public. At the Century of Progress exposition, forty years later, a process also involving refrigeration has been brought to the attention of millions of visitors, some of whom have experienced perhaps for the first time the advantages of air conditioning for comfort.

Originally scheduled to close October 31, it was announced last month that the Fair would remain open until November 12, will probably re-open next year.

Air conditioning at the Fair has been described in two previous articles[1]; to make the record more complete, other of these installations are described briefly this month.

Little Theater Is Air Conditioned—Ten Compressor Units Provide 25-Ton Capacity

By **G. E. Simons***

AN interesting application of air conditioning has been made in the General Electric "House of Magic," a feature of that company's exhibit in the Electrical building. The House of Magic is essentially a little theater in which spectacular developments and discoveries of the G. E. research laboratories are demonstrated. It has a seating capacity of 204, and accommodates approximately 4,600 people per day, a new 25-minute show being started every half-hour.

A total of 25 tons of refrigeration were made available to cool the room, ten small compressor units (Fig. 1) having been installed for test purposes in preference to a single large unit. Each compressor in the group cools water which is circulated through fin coils in the air stream, thus affording temperature control and providing dehumidification. For purification, the air stream passes through a spun-glass filter and is subjected to a washing action as it passes over the cooling coils on which some water has condensed.

Provision has also been made in the system to heat the House of Magic. An oil furnace is connected to supply steam to a second set of fin coils in the air stream, and is under thermostatic control.

The entire system is a testing ground for the equipment built by the company for domestic and small commercial installations; such equipment is displayed in another section of the exhibit.

Gas-Fired Boiler Supplies 100-lb Steam for Steam-Jet Air Conditioning Unit at Fair

By **E. D. Quirke†**

THE steam vacuum system of air conditioning has been accorded considerable mention of late and much interest has been aroused in the general principles involved. A natural consequence is that more study is being given to the component parts of this type of refrigeration.

The evaporator chamber, steam ejectors, and condensers have no moving parts except for the auxiliary pumps. It is by virtue of this simplicity in the design that a person's thoughts soon revert to the boiler end

[1] "A Century of Progress Exposition," HEATING, PIPING AND AIR CONDITIONING, June, 1933, p. 289. "Chicago World's Fair Proves Air Conditioning Attracts the Public," July 1933, p. 360.

*General Electric Exhibit, A Century of Progress, Chicago.

†Kewanee Boiler Corporation, Kewanee, Ill.

of the outfit. Inasmuch as the steam generator has to furnish the only active medium used, and as economical refrigeration is dependent upon its efficient production, no stretch of imagination is required in arriving at the decision that dependable steaming equipment is essential for effective operation of the complete assemblage.

A prominent installation of this kind is at the Fair in the American Radiator "garden of comfort" building. The steam jets are fed from a gas-fired steel boiler.

It will be recalled that in the kinetic steam-refrigeration cycle, venturi jet ejectors create a high vacuum under which water boils at low temperatures; 33 F is approximately the low limit attainable in practice. Provision is made for part of the circulating water to vaporize as it is returned from the cooling system into this vacuum chamber through spray jets. The necessary energy for conversion (evidenced as latent heat of the vapor) is abstracted in the form of sensible heat from the cooling water remaining in the evaporator, which is thereby chilled for recirculation to the coils in the air-conditioning plant. The used steam and vapor are condensed and returned to the boiler.

Fig. 2—At the left is the gas-fired boiler which supplies steam for the steam-jet refrigeration equipment shown at the right. The equipment is in the conditioned exhibit space. Unconditioned air for combustion is taken from outdoors

Boiler at Fair Installation

At the Century of Progress exhibit steam is supplied to the ejectors by a Kewanee firebox boiler at 100-lb pressure, though in steam-jet cooling the pressure does not have to be as high as 100 lb.

Both the boiler and the other steam-jet equipment are located in the space under a balcony which opens directly on the exhibit floor. (Fig. 2.) In order to reduce to a negligible quantity the heat which was radiated into the building when it was being cooled, the outside of the boiler was covered with 4 in. of insulation lagging. The door castings have 4-in. plastic insulation inside. The same thickness of insulation covers the bent pipework leading the spent gases to the stack outside the building. Unconditioned air for combustion is taken from outdoors.

Both nests of the two-pass fire tubes are fitted with spinner blades which whirl the gaseous products of combustion into intimate contact with the tube walls and lengthen their path of travel to increase the quantity of heat absorbed by convection. The resultant low stack-gas temperature of 350 F with the boiler overloaded to an output of 1140 lb of steam per hr at 100-lb pressure contributes materially to the 83.25-per cent efficiency.

In a test giving the figures above, the gas consumption was 1980 cfh. At 800 Btu per cu ft the total heat input was 1,584,000 Btu per hr. Fully automatic controls govern the industrial-type gas burner, protection being provided against gas failure, pilot extinction, high gas or steam pressure and low water.

"Time-Fortune Pavilion" Has Provided Air-Conditioned Reading Room for Public Use

THE beautiful Time-Fortune Pavilion at the Chicago Fair, which was built by the publishers of *Time* and *Fortune*, has the distinction of being the only air conditioned building ever to be erected at a world exposition devoted solely to the purpose of furnishing rest and relaxation, both mental and physical, to the public. An air-conditioning system has provided control of temperature and humidity.

The equipment (York Ice Machinery Corporation) consists of a freon compressor unit with condensing side, driven by a 30-hp motor. The conditioning units are of the floor type.

Fig. 3—Reading room in Time-Fortune Pavilion, showing two of the six floor-type air-conditioning units along the large window. The inset view shows the freon refrigerating unit located in loft above the reading room. The pavilion seats between 250 and 300 people

Photo, York Ice Machinery Corporation

The interior of the Pavilion is attractively furnished as a reading room and lounge, with generous seating capacity. More than 1500 magazines and periodicals from all parts of the world are provided for free public use.

This company's equipment is also installed in several other air-conditioning installations on the Fair grounds. The Florida State Building (a beautiful exhibit forming a portion of the Hall of States) has a central-duct-type air-conditioning system. The air is directed out over the roof of a balcony, the return grilles being at the floor line of the north end of the exhibit. The record day for attendance at this building was 90,000.

The Baltimore & Ohio has a special six-car train on exhibit which is completely air conditioned. This train shows the latest developments in luxurious comfort for the railway traveler. An all-aluminum observation and room car of the new high-speed type is being shown at the Pullman Company exhibit. Thermostatic control is installed to regulate the air conditioning of the car. The air-conditioning system is similar to the equipment used on the B. & O. train.

"World's Smallest Theater" Cooled with System Having a Capacity of Four Tons

WHAT is said to be the smallest theater in the world is utilized by the Household Finance Corporation as a part of its World's Fair exhibit. This company, which extends credit to individuals, presents a ten-minute moving-picture show explaining its method of lending. The theater is equipped to be cooled.

The cooling equipment consists of two Ilg Electric Ventilating Co. compressors and two coolers with self-cooled-motor propeller fans, giving a total of approximately four tons of refrigeration. Air introduction to the theater is through an ingenious series of slots in the ceiling, so concealed that they do not in any way conflict with the decoration of the theater. For exhaust, there is a self-cooled-motor propeller fan drawing out.

New High-Speed Railroad Coach on Exhibit; Air Conditioning is Among Its Features

THE new air-conditioned, high-speed railroad coach with self-contained motor which is on exhibit in the rear of the Transportation building at the Fair has created considerable interest.

Built by the Clark Equipment Company, this car (Fig. 4), sharply streamlined and of aluminum-alloy construction, is designed to maintain a speed of around 75 mph with a top speed of 85. Powered with a 16-cylinder, 160-hp automotive-type engine, it is operated like an automobile, with the conventional gear shift, and again adopting automobile features, it "rides on rubber" for the car-type steel wheels are cushioned on rings of rubber.

A 7-kw generator (operated by a gas engine entirely independent of the main engine that drives the car) provides the power that runs the 2½-ton compressor for the Frigidaire air-conditioning equipment. Conditioned air circulated throughout the car has kept the temperature pleasantly cool regardless of the temperatures outside during the summer. In addition to cooling the air, this equipment dehumidifies it at the rate of from 8 to 10 lb of water an hour. A bucket placed under the car has emphasized this point graphically to the visitors.

Running from Battle Creek to Chicago over the tracks of the Michigan Central railroad with a gathering of prominent railroad executives on board, this new car averaged close to 60 mph. Leaving Battle Creek 15 minutes behind the "Wolverine," crack train of the Michigan Central, it covered 48.6 miles between Kalamazoo and Niles in 44 minutes, while the "Wolverine" required 57 minutes. Then, giving the "Wolverine" a 15-minute start from Niles, it caught up to the flyer and made the distance between Niles and Chicago in 15 minutes less than the time taken by the train.

The coach on view at the Fair is 60 ft long and holds 40 persons, grouped in chairs arranged in the fashion of a parlor car. Another coach is planned to be 86 ft long and to seat 72 passengers. This also will be air conditioned.

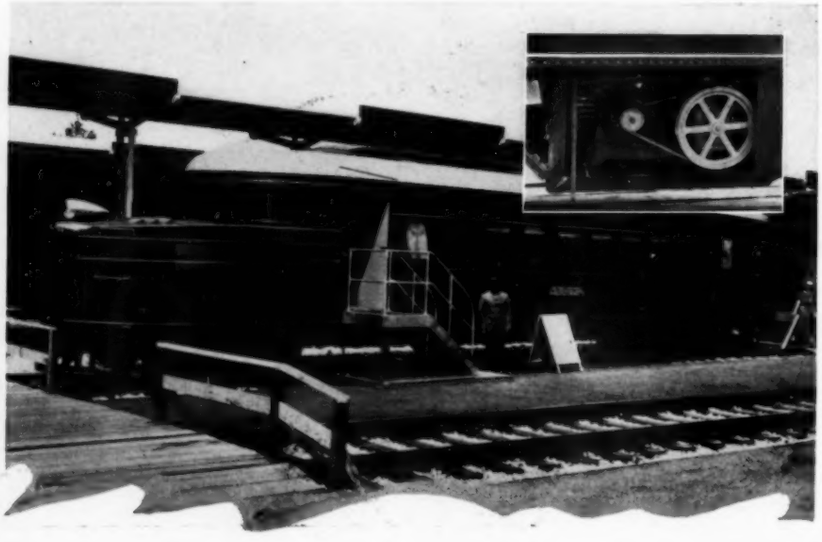


Fig. 4—The air-conditioned and "automobile-powered" railroad car on exhibit at A Century of Progress, with close-up of part of the air-conditioning equipment. Power for air conditioning is supplied by a generator driven by an engine entirely separate from that operating the car

Trapping Unit Heaters for Industrial-Plant Heating

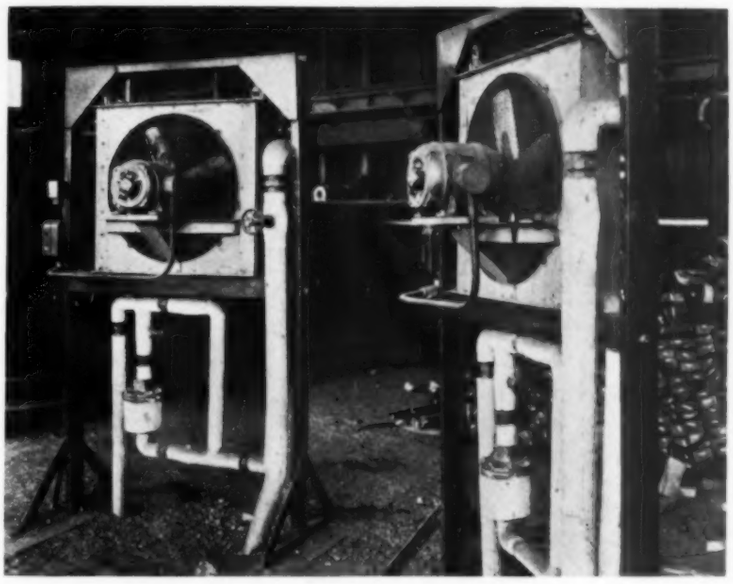


Fig. 1—Unit heaters installed at a large steel plant, showing the traps which drain the condensate to maintain satisfactory operating conditions. Note that the traps are insulated

A STEAM trap is an automatic valve for removing condensate from a steam line or a steam-using heating or process unit without the loss of live steam. As with any automatic machine, no matter what its function, proper selection and installation of the steam trap for the specific application desired is essential to satisfactory and economical results. Periodic inspection after installation is advisable, and should include a record of repair work done, etc. For a discussion of steam-trap installation and maintenance in general (including "real" and "imaginary" trap troubles) the reader is referred to a series of articles by T. H. Rea,[1] which were published in H. P. A. C., December, 1929, to April, 1930.

It is the purpose of this article to discuss the selection and installation of traps for industrial unit-heater systems. As the ultimate success of such a system depends upon the proper drainage of each unit, too much emphasis cannot be placed on the importance of the traps.

[1]Of Armstrong Machine Works, Three Rivers, Mich.

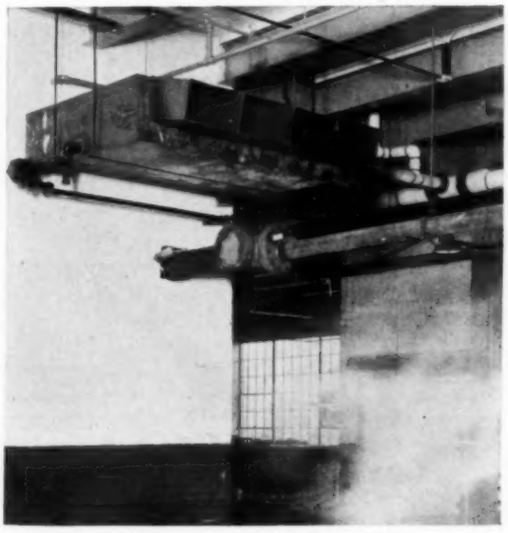


Fig. 2—Trap installed on a large unit in Liquid Carbonic Company plant in Cleveland. The heater has a capacity of 6100 cfm, 422,400 Btu per hr, with 5-lb steam pressure and 60-F entering air. It is necessary for the trap to handle 440 lb per hr of condensation

Similar to Trapping Process Equipment

While basically all trap problems are pretty much the same, the specific application imposes a number of requirements which must be met. In this connection, the selection and installation of a trap for a unit heater may be said to be more similar to trapping steam-using process equipment than, for instance, a direct-radiation heating system. As pointed out by R. L. Clark,[2] in radiation such as cast-iron radiation or pipe coils, the volume of

[2]Of The Strong, Carlisle & Hammond Co., Cleveland, Ohio.

***UNIT HEATERS** are widely used for effective, economical plant heating, as was described in an article on the subject in the September issue. In addition to industrial space-heating applications, unit heaters have many "process" uses — drying, fog-dispelling, etc.—have solved many a production problem. An article last month described installations of this kind. . . . . This month the subject of trapping unit heaters is discussed, the problem is outlined, the solution considered.*

steam stored in the unit is relatively high in proportion to the amount condensed over any given period of time. With a unit-heater system, the contrary is true; the quantity or volume of steam stored within the unit is small in proportion to the quantity condensed over a certain period. Because the unit heater condenses steam so rapidly in proportion to the amount of exposed surface and the volume of steam-storage space in the unit, rapid and complete evacuation of all non-condensable gases (such as air) and condensate is important to successful operation. This is similar to the situation met with in applying traps to process equipment using steam, such as cooking kettles, submerged radiation and coils, etc.; tube-type heaters and other heat-exchange apparatus present similar conditions.

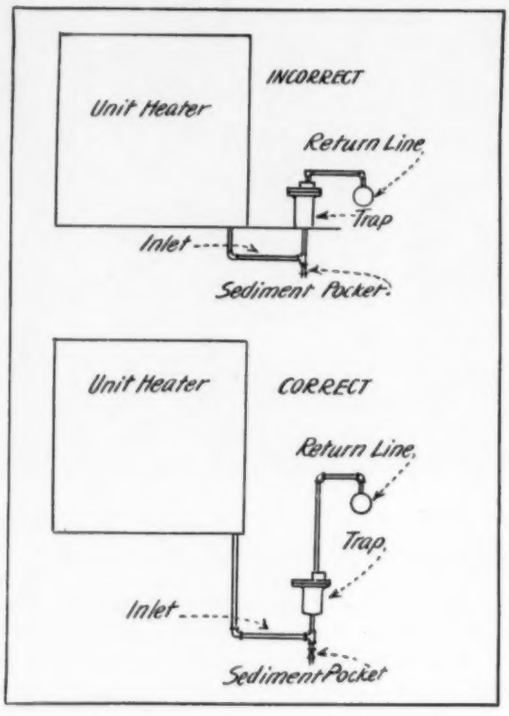


Fig. 3—To facilitate the condensate flowing into the trap by gravity, the trap may be dropped below the unit heater and the condensate lifted to the return line in cases where the return line is on the same level with the heater

Importance of air elimination is stressed in one manufacturer's[3] data book, where it is stated "proper venting of air is vitally important due to the ratio of heat output to the volumetric contents of the heating element. A small quantity of air confined in the unit will blank off a large proportion of the heating surface."

Also, it is pointed out by A. G. Getz[4] that in selecting a trap for unit-heater work, consideration must be given to the fact that the heater sections are subjected to a continuous blast of air, and that the temperature of the air may vary over a wide range, and that there are changes in the speed of the fan and in the steam pressure. These natural variations of condensate and pressure should be accommodated; a trap having a maximum capacity of two or three times the normal capacity may be selected in some instances.

[3]Hoffman Specialty Company, Inc., Waterbury, Conn.
[4]Of The Bishop & Babcock Sales Co., Cleveland, Ohio.

Use of Capacity Tables

The capacity tables shown in the data books, catalogs, and bulletins of the manufacturers of this equipment are of course used in selecting the proper size of trap; these publications also contain a great deal of information on applications and piping hook-ups which will be found of value in insuring a trouble-free installation. In making use of such tables, it is important that it be possible to choose between the various makes and types on a comparable basis; not only is this important when determining the relative value of several different makes, but is also essential to insure ample capacity for satisfactory operation. A trend has been toward using as a rating basis the continuous or uninterrupted flow of water through an orifice of the size used in the trap at the pressure specified.

Effect of Pressure on Capacity

Practically all steam traps are designed to operate most efficiently between certain differential pressure ranges. In a mechanical trap of certain size the maximum size of orifice for any differential pressure is determined by the force (through the weight of a bucket sinking or the buoyancy of a float rising multiplied through a lever system) available to remove the valve from the seat against the pressure. As the weight of water does not change appreciably with temperature or pressure change, this force remains constant; therefore, to adapt a trap to operate at maximum capacity at various pressures, the orifice must be interchangeable and the trap fitted with the proper seat which will operate with the highest differential pressure on the system. The size of the largest allowable seat orifice varies inversely with the pressure.

An example cited by Mr. Clark[2] illustrates this point:

Assume a typical small trap, and that the bucket in sinking (or the float in rising) exerts a force of 6 lb on the valve, tending to open it. This trap must therefore be fitted with a seat which at the designated pressure will require less than 6 lb to open the valve. Assuming that it is desired to use this trap on a maximum working differential pressure of 100 lb per sq in., dividing 6 by 100, gives 0.06 sq in. or the maximum area which can be used in this size trap at 100 lb pressure. Referring to a table of areas, it is found that a 17/64 orifice has an area of 0.0354 sq in. and by equipping the trap with this orifice approximately only 3.5 lb would be required to remove the valve from its seat, giving approximately 0.5 lb margin of safety against wear, etc.

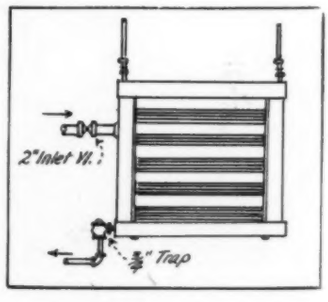


Fig. 4 — This unit heater is equipped with an internal cooling leg to permit installation of the thermostatic trap at the unit

The same trap may be used for 30-lb pressure,

and in order to obtain its maximum capacity, the seat orifice would be changed. Dividing 6 lb force by 30 lb pressure gives 0.2 sq in. of area as the maximum allowable at 30 lb pressure. Again referring to a table of areas it is found that an orifice having a diameter of ½ in. has an area of 0.196 sq in. Multiplying this by the pressure it is found that it would require a force of 5.88 lb to remove the valve from its seat. With 6 lb available, no difficulty would be had in making the trap operate satisfactorily at the designated pressure.

It is thus seen that if we take a 30-lb trap fitted with a ½-in seat having an area of 0.196 sq in. and attempt to operate it at 50 lb we would simply have a force equal to 0.196 (area) × 50 (pressure), or 9.8 lb, holding the valve against the seat with only 6 lb available for removing the valve from its seat. The trap, of course, would close and refuse to open. This one difficulty has caused almost as much trap trouble as all the other causes combined.

On the other hand, if this 30-lb trap were to be operated at 10 lb, multiplying 0.196 x 10, requires a force of only 1.96, or approximately 2 lb, to open the valve, and the trap would work satisfactorily except for the somewhat reduced capacity. Of course it is unnecessary for the designer or engineer who lays out the job to make all of these calculations, as this is the manufacturer's responsibility. It is, however, well worth any engineer's time to understand thoroughly the principle in order to specify or select traps for the job intelligently.

Differential and Working Pressure

Confusion and misunderstanding is the result of failure to indicate the differential pressure rather than the working pressure. The differential pressure is of course the difference between the pressures at the inlet and outlet expressed in *absolute* pressure. For ease in understanding, however, let us convert it to terms of the commonly-used *gage* pressure. Where a trap discharges against a back pressure, therefore, this back pressure should be subtracted from the pressure on the inlet of the trap to arrive at the differential, and conversely when the trap discharges into a sub-atmospheric pressure or vacuum, this pressure should be added to the inlet pressure in order to secure the correct differential.

To illustrate, suppose the trap operates at 30-lb pressure and is required to discharge into a line where the condensation must be lifted 50 ft vertically. As it requires approximately ½-lb pressure to effect a vertical lift of 1 ft, the 50-ft lift would require a back pressure in the return line of 25 lb. The differential pressure on this trap, therefore, would be the difference between 30 and 25, or 5 lb, and the capacity of the trap reduced to that extent. On the other hand, assume that the same trap is discharging at times into a vacuum as high as 20 in. As 2 in. of vacuum are (in round figures) equal to 1 lb, there is the equivalent of 10 lb vacuum on the trap outlet. By adding this to the inlet pressure of 30 lb, it is found that there is a differential pressure of 40 lb on the trap installed under these conditions, and of course if the trap were fitted with a 30-lb seat, it would fail to open. Such difficulties are by no means out of the ordinary and can readily be prevented.

A thorough understanding of the operating principles of a trap assists in a selection of the proper equipment and the job of selecting traps for unit heaters resolves itself into a relatively simple one, leaving only the matter of correct installation.

Installation of Traps

Under normal conditions the pressure inside the trap is the same as that in the unit heater and water of condensation must consequently flow to the trap by gravity. It is therefore important to have the trap far enough below the point to be drained (one manufacturer says at least 18 in.), using a somewhat larger pipe for this connection; by these means, the capacity of the trap can often be increased. For example, if a heater with a 1-in. drain connection were to be fitted with a ½-in. trap, a 1-in. line leading down to the trap and reduced at the trap inlet to ½ in. (rather than at the heater) would be recommended. Often the return line is on the same level as the heater, and in cases of this kind the trap may be dropped below this line and the condensate from the discharge of the trap lifted to the return. Fig. 3 illustrates this point.

With thermostatic traps, it is important that the trap is handling water cool enough. It will be noted from several of the sketches shown here that cooling legs from the heater to the trap are provided for; one type of unit heater (see Fig. 4) has incorporated in it an in-

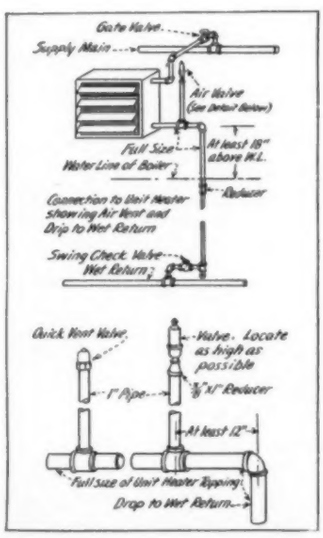
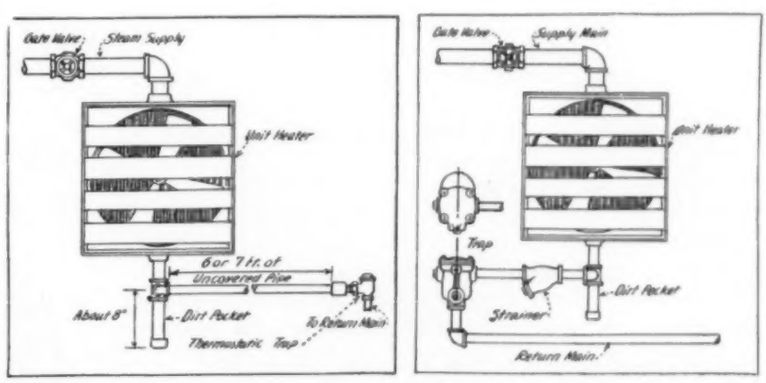


Fig. 5—Installation of air valve

Fig. 6—(Left) Thermostatic trap installed to drain a small unit heater. (Right) Combination float-and-thermostatic trap as installed on larger unit heaters



ternal cooling leg designed to insure that the condensate will be cool enough to be handled by a thermostatic trap.

Elimination of Air

As has been mentioned, the elimination of air from unit heaters is of especial importance; particularly on installations where raw water is used in the boiler must this be given attention, as considerable air is introduced into the steam piping thereby. In some installations, particularly large ones, an independent air vent from the draining device has been provided, with a separate tapping from the heater.

Fig. 5 shows an installation of an air-eliminating valve.

Traps especially equipped for eliminating large quantities of air are available. With several types of combined mechanical and thermostatic traps of either the inverted-bucket or float types the air is handled by a valve entirely separate from the regular trap discharge valve. The traps are either fitted with a bi-metal or bellows-operated valve which is set to close at a temperature somewhat below the temperature of steam at the pressure used on the particular unit. When starting, the auxiliary air valve is open wide and any accumulation of air is rapidly expelled. As soon as steam reaches the trap, it expands the thermal element.

Use of Strainers and Dirt Pockets

Many engineers insist on the use of strainers ahead of all steam traps or similar equipment, and in the case of trapping unit heaters this may be of particular value in many instances as the orifices are quite small. There is some difference of opinion regarding this point, as it is argued that strainers are often allowed to fill with sediment, restricting the flow of condensate to the trap. Several of the sketches shown here indicate the installation of strainers or dirt pockets; in cases where strainers may not be used, installation of dirt pockets is suggested. Strainers of "self-cleaning" types are available and are designed to overcome the objection mentioned.

It should be pointed out in this connection that traps are designed to "handle" a certain amount of dirt.

In a recent issue of H. P. A. C., A. W. Moulder[5] pointed out an advantage of installing strainers *ahead* of the unit heater. It has been the habit to install strainers at the return end of pipe coils to prevent scale and dirt from the coils injuring the valve or trap in the return connection; this practice has continued with unit heaters. It would seem advisable, he concludes, to place the strainer in the supply connection to the unit heater so that it will protect the relatively small and valuable tube area of the unit as well as the trap in the return tapping from the heater. Fig. 5 shows an installation of

Proper Valves Aid Operation, Maintenance

In connection with the use of unit heaters it is of importance that the trap be provided with necessary valves, etc., to, first, eliminate as much trouble as possible; second, to enable the operator to quickly locate any trouble; and third, provide means whereby the trouble can be quickly and easily cured. The installation diagrammed

[5]Of Grinnell Company, Providence, R. I.

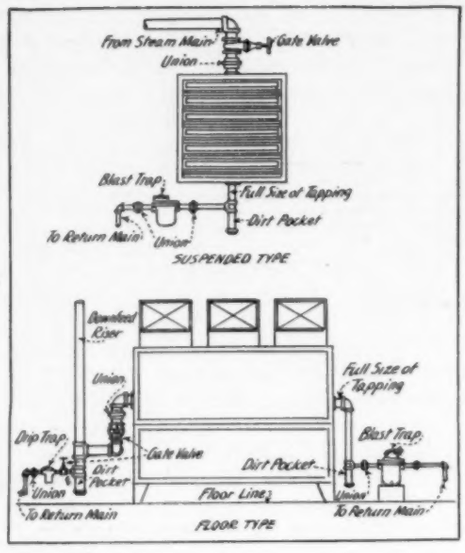


Fig. 7—Unit heater connections as recommended by one company for suspended and floor-type units

in Fig. 8 is mentioned as an example of this point by C. E. Ammeson.[6]

The sketch, at first glance, seems to include unnecessary valves, but a close study indicates that each item shown has an important use. The sediment separator, or strainer, catches the dirt, sediment, or scale which is nearly always present in greater or less quantities, keeping this material out of the trap, thus eliminating trap trouble from this cause. The blow-off valve at the bottom of the sediment separator enables the operator to blow off the accumulated dirt at regular intervals.

The inlet and outlet stop valves allow shutting off the trap when desired for examination, cleaning and repairing.

A test valve is also advisable for the purpose of testing the operation and tightness of the trap. A tee is placed in the discharge line between the outlet of the trap and the outlet stop valve, and a small globe valve screwed into the side opening of this tee. To test operation of the trap, the outlet stop valve should be closed (to be sure no back pressure flows out of the test valve), the inlet stop valve remaining open. By opening the test

[6]Of Crane Co., Chicago, Ill.

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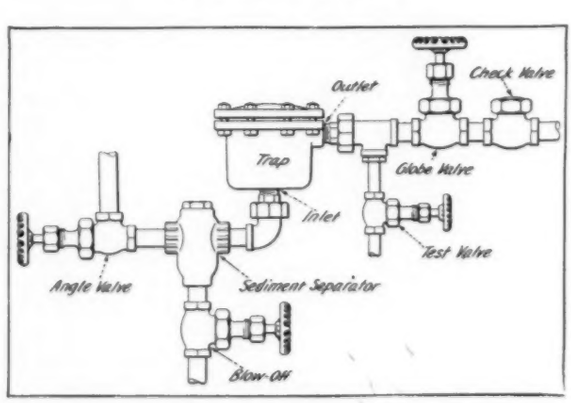
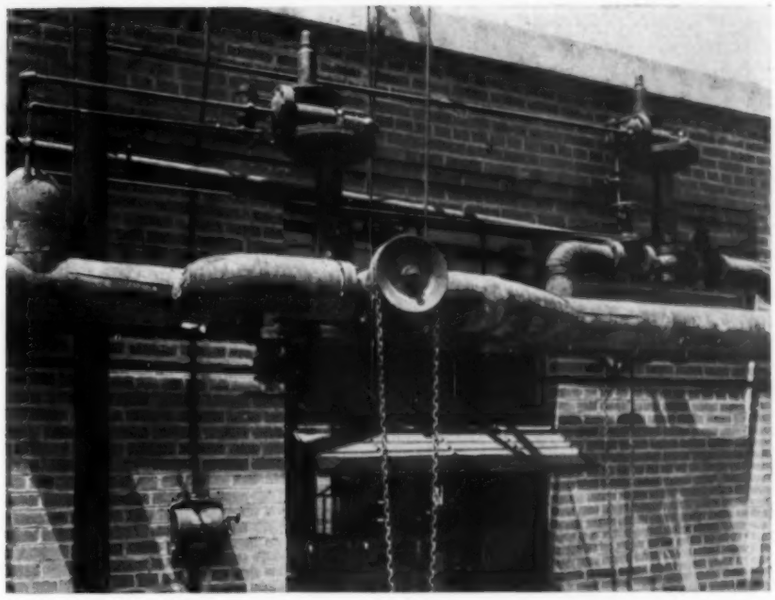


Fig. 8—Sketch showing valves installed to aid operation and maintenance of a unit-heater trap

Fig. 1—Pilot-operated reducing valves for live steam make-up



By **Harold L. Colby***

Selection of Pressure Regulators

IN THIS article, the author gives some practical pointers on the importance of the proper sizing and installation of pressure-regulating valves. Frequently such equipment may be blamed when the real fault is a mis-application or an improper installation....The piping arrangement has a distinct bearing on the success of pressure-regulating equipment, and — as described here — this effect must not be overlooked if trouble-free service is to be obtained.

ELIMINATION of future trouble and longer life for the equipment are among the dividends earned by giving proper attention to the selection of pressure-regulating apparatus. Considerable data on this subject are available in text-books and in technical and engineering journals; manufacturers of course have capacity tables or charts applying to their equipment which can be utilized to advantage when an installation is contemplated. It is the purpose of this article to outline in a practical way, some of the things to consider in the selection of pressure-regulating equipment, rather than to present a technical or theoretical treatise on the flow of steam and pressure regulation.

Oversizing of Pressure Regulators

Instances of over-sizing of pressure-regulating valves are numerous. An example will suffice to show how this occurs:

A plant (let us say) is operating a boiler supplying steam for heating purposes; pressure over 15 lb per sq in. is not needed. Then a process is added which requires 60- or 80-lb pressure with the problem of supplying approximately 5-lb steam for heating. The heating main in the original lay-out was 5-in., capable of taking care of the heating load of 10,000 sq ft of radiation or approximately 3000 lb per hr at about 5-lb pressure, with a margin for increased loads. Faced with the need for reducing 80-lb steam to 5-lb, a 5-in. reducing valve is purchased without too much thought.

If a pipe line were to be installed to pass 4500 lb of steam per hr at 80-lb pressure, it would not be a 5-in. line but, say, a 2½-in. This applies to the problem of pressure regulation as well and therefore, a smaller-size valve is required. The size can be reduced because of the drop in pressure that is going to be taken through the valve. They are planning to keep their high-pressure main of a size that will carry the load, with but a minimum drop due to friction in the 80-lb steam line up to the valve. In this particular instance it was necessary to maintain maximum steam pressure for process work and so the high-pressure service was brought up to the valve in a 2½-in. line.

The valve size best proportioned to the heating load might be 2-in., and the simple installation of reducing fittings on either side of the valve would give the desired results. (Fig. 2).

For a comparison of the expected results of the two valves (2-in. size and 5-in. size and both of the same make and type), let us consider the maximum port area necessary for the full-load conditions. The area of the port opening required to pass 4500 lb of steam per hr

*Engineer, Mason-Neilan Regulator Co., Boston, Mass.

reducing 80 lb per sq in. to 5-lb is 2.4 sq. in. For the purpose of this discussion we will use the double-seated type of valve. The 5-in. valve has a maximum area of 19.63 sq in., requiring a poppet lift of approximately $\frac{5}{8}$ in. (circumference 15.7 in. x $\frac{5}{8}$ equals 9.8 sq in. x 2 for double seat equals 19.6 sq in.). The 2-in. valve has a maximum area of 3.14 sq in., requiring a poppet lift of approximately $\frac{1}{4}$-in. (circumference 6.28 in. x $\frac{1}{4}$ equals 1.57 sq in. x 2 for double seat equals 3.14 sq in.). If the 5-in. valve were used, when only 2.4 sq in. maximum port opening is required, let us see what lift is necessary and how far the poppet is lifted from the seat.

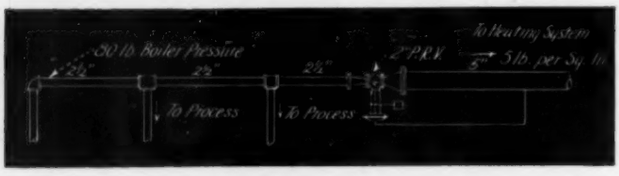


Fig. 2—Installation of reducing valve for supplying 5-lb steam for heating from an 80-lb process steam line. See example in text

The 2.4 sq in. required, divided by the circumference (of 5-in. poppet), 15.7 in. ÷ 2 for double seat equals 0.076 in. or approximately $\frac{3}{64}$ in. This is the maximum lift required at any time, including provision for future load. Considering the present requirements and the fact that a great percentage of the time the load conditions are nowhere near maximum, the valve is just "cracked off its seat" and subject to wire drawing and the cutting action of steam with entrained moisture and condensate usually carried with it.

To complete the comparison, let us look at the same situation using the 2-in. valve. The 2.4 sq in. required, divided by the circumference (2-in. poppet), 6.28 in. ÷ 2, for double seat, equals 0.191 in. or a trifle over $\frac{3}{16}$ in. This is about three-fourths the maximum lift which places it in a favorable position for good results. There is still the factor of reduced load, but with sufficient lift to reduce materially the wire-drawing effect.

Limitations of Piping Arrangement

A factor in pressure-regulating control quite frequently overlooked, particularly with reference to the maximum capacity of the valve, is the limitation caused by the piping arrangement and sizes. A manufacturer usually rates the capacity of his valves at a maximum, based on the pressure drop to be handled by the valve. If the outlet piping is not proportioned to the load requirements at the reduced pressure to be carried, friction losses will be set up in the low-pressure main which will react unfavorably to the user. This is particularly true if a long run of main is installed in transferring the low-pressure steam to some remote point. Quite frequently it is desired that the pressure be maintained at this more remote point and the gage or indicating device for registering the pressure is located at that point. The regulating valve is capable only of maintaining the reduced pressure at the point where the feeler pipe or reduced-pressure connection is taken. Friction losses beyond that point will set up a variable reduced pressure and may cause criticism of the reducing equipment for its inability to maintain the pressure at some other point.

This is particularly true when using a reducing valve for live steam make-up to exhaust systems. Generally, in an installation of this sort the reduced-pressure main from the reducing valve to the exhaust main is somewhat smaller. This necessitates that a higher pressure be maintained in this branch line to supply sufficient steam, under maximum load conditions, to maintain the desired pressure in the exhaust line. Consequently, if the control pipe to the regulating valve is taken from this intermediate line, a variable pressure will result at the ultimate point. It is clear that under these conditions at maximum flow, the reducing valve is over-set, in order to deliver the proper amount of steam necessary to maintain the desired reduced pressure in the exhaust main. Under light loads, or when the reducing valve is not called upon to deliver steam, the over-setting of the regulator that was necessary for maximum load conditions is objectionable and builds up the pressure, requiring a re-setting of the valve—which removes it from the automatic classification.

This can be eliminated by taking the control point from the desired point, under which conditions it makes no difference what the pressure may be in the outlet of the reducing-valve body or in the piping between that valve and the main where the pressure is desired.

This point can be illustrated by the case of an application of a reducing valve to an industrial machine. If the reduced pressure is desired within an enlarged chamber of considerable capacity, and thought is not applied to the problem before installation is made, the pressure connection to the diaphragm may be taken from the main preceding a number of fittings and valves and the entrance to the enlarged chamber. This arrangement is similar to that previously described for supplying steam to an exhaust main. Here again a false pressure will be set up in the container, although if a gage were placed at the control point in the supply line or reduced-pressure main, it would be found to maintain accurately the pressure setting. But the results in the machine

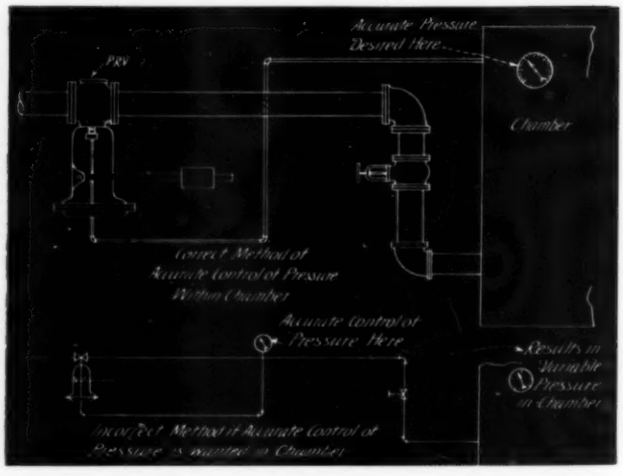

Accurate Pressure Desired Here
PRV
Chamber
Correct Method of Accurate Control of Pressure Within Chamber
Accurate Control of Pressure Here
Results in Variable Pressure in Chamber
Incorrect Method if Accurate Control of Pressure is Wanted in Chamber

Fig. 3—As explained in the example to which this illustration refers, the point of connecting the pressure-control line is important

will be variable, depending upon the flow conditions, with a separate reduced-pressure reading for each increment of flow from zero to maximum. Fig. 3 illustrates this point.

The principal reason for discussing these two illustrative installations is to show that frequently the pressure-regulating valve is blamed when the real trouble is a mis-application or incorrect installation. A great many times the valve is considered too small for the work when the valve is more oversized than not, if it were properly connected up.

Another angle in the installation of pressure-regulating valves, which ultimately reflects on the size of valve, is the size of the outlet or reduced-pressure piping on any given installation. It was mentioned in the first example that a 2½-in. supply pipe was sufficient, at the high pressure of 80 lb, with a probable 5-in. reduced-pressure main for the low pressure of 5 lb. The reason for this will be seen when comparing the "specific volume" of the two pressures. The specific volume or space required per pound of steam at 80-lb pressure is 4.65 cu ft. The specific volume of the low-pressure steam (5 lb) is 20.08. In other words, the low-pressure requires 4½ times the pipe area of the high-pressure steam.

The ratio of areas between the 2½-in. supply main and the 5-in. reduced-pressure main is about four, approximately the ratio between the specific volumes. Thus the low-pressure main will carry practically the same quantity of steam at the same velocity as in the high-pressure pipe. Under these conditions the losses due to frictional resistance will not be objectionable.

Preventing Cutting Action of Condensate

It is not amiss to bring out in this article one or two points which are helpful in protecting the seats and poppets as much as possible. This insures the user of the maximum service from his equipment with a minimum of servicing charges. The oversizing of a valve will contribute to wire drawing and the cutting of the seats on the poppet. Extreme cutting action is caused by the condensate carried along with the steam. It is, therefore, essential that this condensate be removed or prevented from passing through the valve with the steam if possible.

This can be accomplished in two ways. Either the supply pipe can be pitched away from the valve so that the condensate will tend to flow counter to the steam flow or if this is not possible, the constant removal of condensate may be assured by dripping to a trap. This often prevents sediment from gathering on the seats or within the working parts of a valve while it is closed. Precautions of this nature are well worthy of consideration at the time of installation and the added expense is practically nothing compared to the savings that are accomplished over a period of time. Fig. 4 should be referred to in this connection.

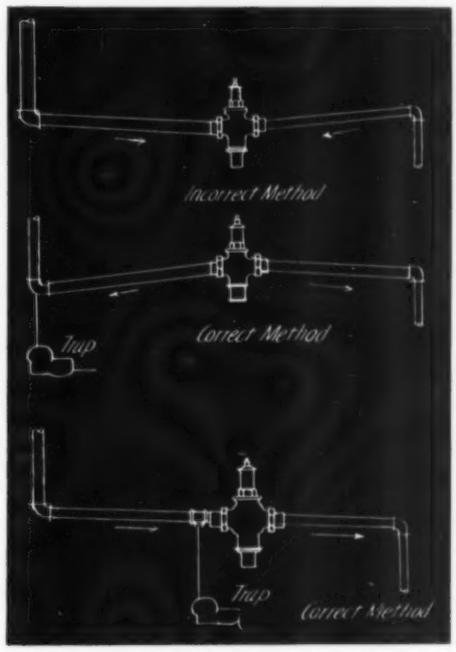


Fig. 4 — Damage to the pressure-regulating valve from the condensate carried in the steam can be eliminated by dripping to a trap

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Supervision, Proper Equipment Save Time and Money in

Piping Maintenance

By **W. H. Wilson***

SUPERVISION is most important wherever labor is involved, particularly so in the maintenance of industrial piping.

Maintenance and repair work is diversified and irregular; conditions arise on short notice where action without delay is necessary. No one can foresee all of the things that may happen; however, competent supervision will accomplish wonders in eliminating delays, shut-downs, and increased operating costs, and in keeping repair-work costs at a minimum. A well-regulated and properly supervised plant does not have many breakdowns without some advance indication of the trouble to give time to make necessary preparations; it is here that proper supervision is an advantage.

The following illustrates my point:

Fig. 1 shows a 6-in. steam expansion joint *E* of flexible, corrugated copper, with solid cast-iron end flanges, installed on a steam turbine, that had to be renewed on short notice. Attention is called to the type

*Member of Board of Consulting and Contributing Editors.

of the original joint, as compared to the one that was furnished *(F)* for substitution; also that the flanged joints at *B* and *C* are secured with stud bolts.

At first glance it appeared that by removing the bolts in the end flanges of the expansion joint and taking out the old joint, the new joint could be slipped in place and bolted in position. The stud bolts prevented this, as the shape of the new joint would not permit the studs to be inserted. The replacement of the expansion joint was accomplished this way:

The large cast-iron off-set pipe *A* (weight 350 lb) was supported temporarily by wood blocks and bolts were removed at *D*. The copper portion of the original expansion joint was cut away, bolts removed at *D*, and nuts taken from the studs *C*, allowing the end flanges of the expansion joint to be removed. Nuts at joint *B* were taken off, the large off-set pipe slipped from the studs, removed and placed aside. These pipe connections had been in service for some time, which made it necessary to proceed with care in dismantling. Penetrating oil was used to good advantage in starting the nuts and studs.

The studs at *B* were removed, well lubricated, and tried out in the tappings to make sure they could be easily inserted when needed. For the time being the studs were laid aside. After cleaning and scraping all of the gasket faces, the new expansion joint was placed in position by slipping the end flange over the studs, at *C* and bolting the joint tight. The large off-set pipe *A* was lowered into position, and the studs for the joint inserted by using two thin grip nuts as lock nuts to drive them in place. The lubrication and previous trial insertions helped to insert the studs readily to the proper depth. The bolts for the joint *D* were inserted as shown, nuts applied at joints *B* and *D* and both joints bolted tight. Temporary supports were then removed. The oil reservoir, oil piping, cooling water and sealing water connections were obstructions in the free use of the wrenches in tightening the bolted joints. Special angle, box-type and socket wrenches were used, being well adapted for this work.

This job could have been simplified with a little more "advance" supervision. The use of an expansion joint of the same type as the original one would have allowed the stud bolts of the joint *C* to be inserted from the side of the end flange toward the center of the expansion joint and by using end flanges of the split (two-piece) pattern, the end flange could have been placed in position after the joint had been set in place, making it possible easily to screw the stud bolts of the joint *C* in place, slip on the two-piece end flange, apply the nuts, bolt the joint tight, eliminating the removing and replacing of the large off-set pipe and the cleaning and scraping of additional gasket faces, removing studs, the temporary supports and the overhead crane service for hoisting and lowering.

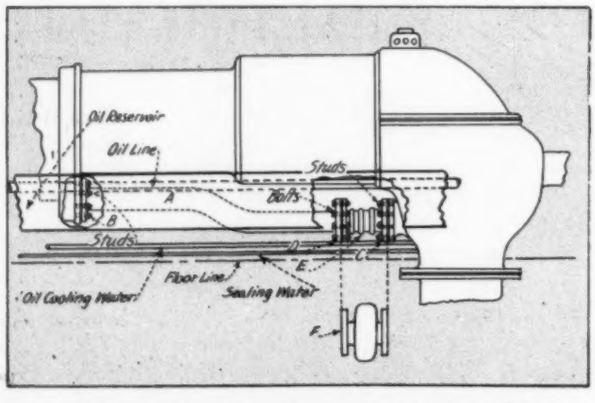


Fig. 1—With a little more advance supervision, replacement of this old expansion joint could have been simplified

In addition to supervision, proper tools, supplies and equipment are essential in order to eliminate delays and insure good workmanship. The handling of heavy pipe, valves, and fittings can be done conveniently with suitable chain hoists. By using two good chain hoists with suitable steel cable slings, heavy material can be placed in proper position when working in close quarters. Good lighting fixtures also should be provided. Much time and labor are lost in trying to accomplish something where there is not sufficient light to see that pipe work is properly assembled. A good light is particularly essential when inspecting the faces of joints to see that they are properly cleaned and gaskets are placed accurately in position before bolting tight.

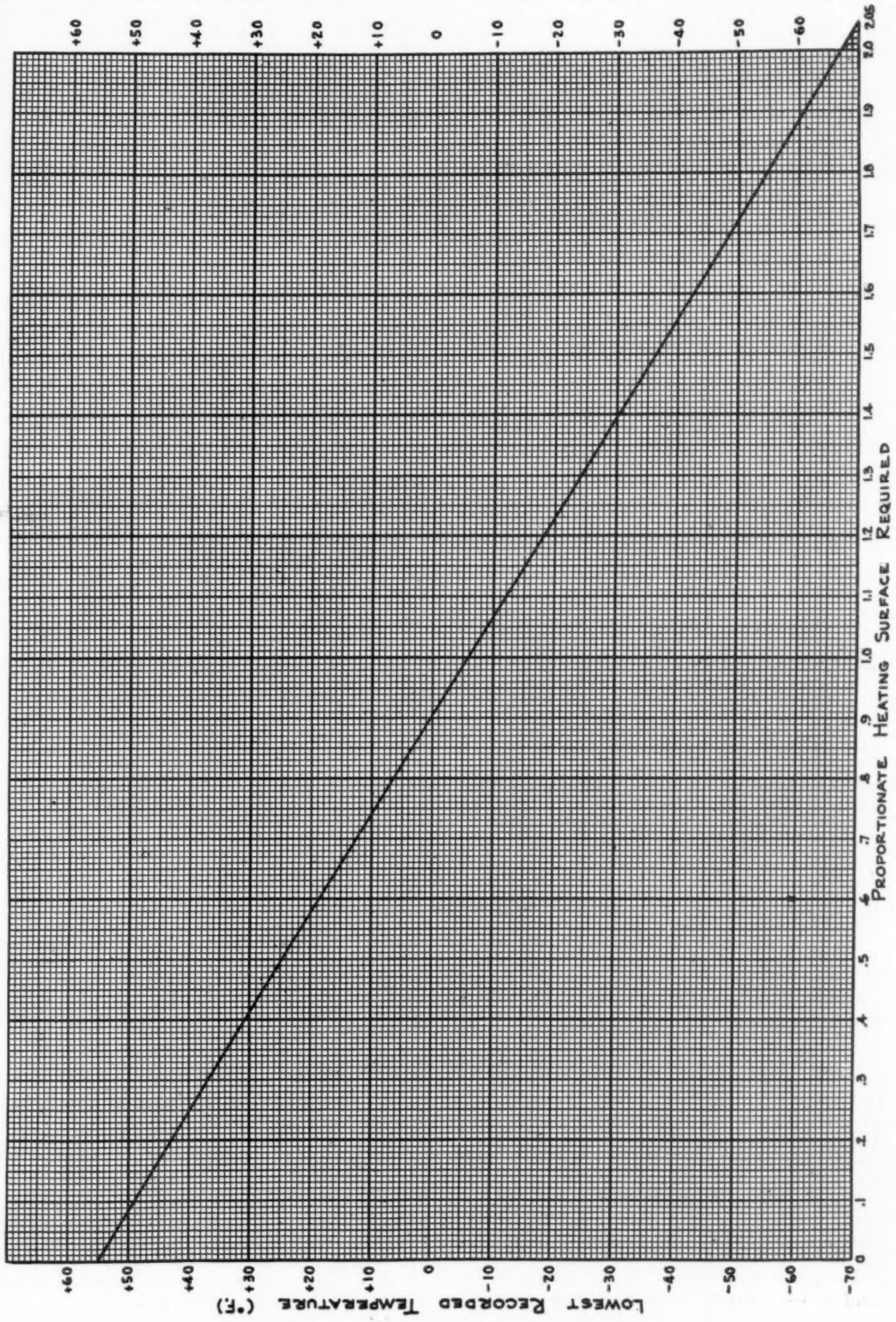
One time-consuming delay on large repair jobs is the shutting down and draining of pipe lines preparatory to proceeding with the work. This can be helped to a certain extent by trying out the shut-off valves beforehand. Large valves on main steam lines which are used infrequently need oiling and operating a few times before the valves can be closed—and then the valve may not hold tight. It may be necessary to open reliefs to the atmosphere to take care of this leakage. This matter should be considered beforehand and arrangements made to take care of this condition without causing unnecessary delay. Valves on underground water mains are no exception, and it pays to check over all of the shut-off valves before starting a repair job. The valves may require opening and closing several times to insure proper seating. It may be necessary to open a hydrant or standpipe and flush out, to remove interior obstructions. The handling of valves on loop or circuit mains, where some of the valves "Open to the left" and others "Open to the right" is not a simple matter. It is possible to get into a mix-up that may require some time to correct.

Many other time-and-labor-saving items can be taken advantage of by careful supervision. When it is necessary to remove gaskets, valve bonnets, strainer covers and other bolted joints that have not been disturbed for some time, the bolts can usually be removed one at a time, the threads lubricated, nuts run over the threads until they move freely and then replaced in the joint, until all have been gone over; this to be done without shutting down the pipe line. When the time comes to make the necessary repairs, inspection or alteration, close the shut-off valves, drain the line and it is surprising how much time is saved and how easily the work is performed when the bolts can be readily removed, as compared with the difficult and time-consuming process of removing rusty and corroded bolts. Gasket joints that are leaking slightly can, in many cases, be stopped in this manner.

In contrast to this method of repairing a flanged joint, it may be better (in case the bolts are rusted and corroded and there are no other objections) to cut off the old bolts with a cutting torch and supply new bolts for the joint. Stud bolts should be provided where there is a limited clearance for using wrenches for tightening the bolts.

Calculating Heating Surface for Buildings 8

. . . . by Price L. Rogers, Consulting Engineer, Philadelphia, Pa. This series of charts (the first of which was published in the April, 1933, issue with an explanation of the series) has been based on a lowest recorded temperature of — 6 degrees Fahrenheit and a 61-degree temperature difference, which, if the base temperature is taken as 15 degrees above the lowest recorded temperature, permits their direct use in New York and Philadelphia. The chart shown here gives the proportionate heating surface required for "lowest recorded temperatures" from — 70 to + 55 F.

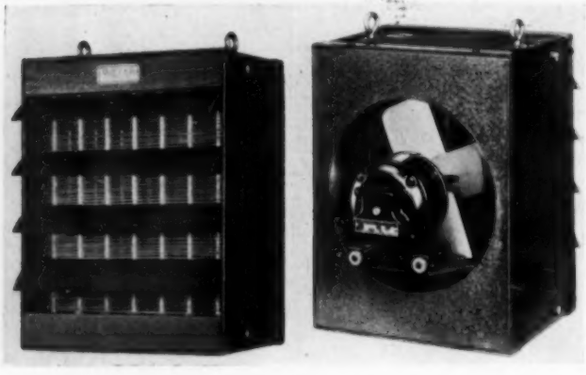


INTERESTING Equipment..... Developments

Announces New Line of Unit Heaters

A new line of unit heaters, replacing their present line of propeller-fan type heaters, has been announced by C. A. Dunham Company, 450 E. Ohio St., Chicago.

The heating elements are essentially integral units; seamless drawn copper tubes, streamlined to reduce air resistance, are forced into die-pressed copper sheets forming the fin surface. A tight mechanical joint between tubes and fins is obtained by the formed collars on the fins, but to assure permanence of heating capacity, the assembly is coated with a high fusing temperature solder. This coating is designed to make a perfect metallic joint, closing the slightest opening which might be present and excluding dirt, dust, and oxidation which would, in time, insulate the fins from the tubes. At each end, the tubes are pressed into heavy copper header sheets and brazed. The supply end of each tube is fitted with a restricting ferrule to assure equalization of



the steam pressure throughout the steam header. The header sheets are then rolled over one-piece bronze castings and brazed in place.

The supply and return tappings are in opposite corners of the heating element, thus securing an approximately equal path for the flow of steam through the element regardless of the path followed. This feature (together with the restricting ferrules) is designed to eliminate the tendency of the heating element to air bind as there is no "short cut" for the steam and no low-pressure area for the air to collect. Every assembly is factory tested under 175-lb hydrostatic pressure and is suitable for working pressures up to 100-lb gage.

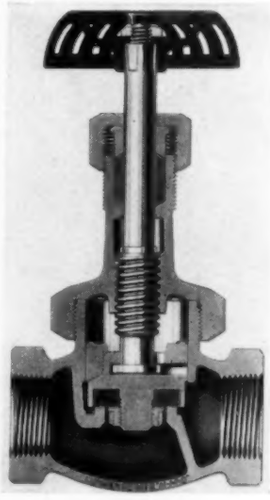
The casings are of heavy-gage furniture steel, trimmed front and back with solid steel bars. The finish is a crinkle lacquer. Quiet motors of standard manufacture are used, providing one, two- or three-speed operation. They are cradle-mounted in live rubber to prevent transmission of hum or vibration to the casing or piping. Eyebolts are provided at the top of the heater for fastening to band iron hangers; the units are light in weight.

Ratings are based on tests conducted in accordance with the code adopted by the *American Society of Heating and Ventilating Engineers* and the *Industrial Unit Heater Association*, according to the announcement. Seven sizes are available, ranging from 130 to 1100 sq ft of equivalent direct radiation. The number designating the heater is the E.D.R. rating of the unit at the "normal" or highest rated motor speed. Special fans are provided for odd-frequency a-c motor speeds to furnish the same capacities that are available on 60-cycle a-c and direct current. A new bulletin containing full descriptions and complete ratings of these unit heaters is available.

New Non-Metallic Disc Bronze Valve

The Lunkenheimer Company, Cincinnati, Ohio, has just announced a non-metallic disc bronze valve suitable for 150-lb steam pressure and 300-lb gas-liquid pressure. The valve, illustrated here, has a deep non heat malleable-iron handwheel with an easy grip. The stuffing box is extra deep and holds a generous supply of packing. Bronze gland in all sizes has hexagon head to facilitate removal.

The heavy stem is made of rolled bronze. Long threads are fully engaged with bonnet thread when valve is closed. Shoulder above the stem thread seats tightly against bottom of stuffing box making the valve repackable under pressure. The one-piece bronze bonnet screws over the sturdy body neck; the flat face bonnet joint is easy to clean, says the maker, who also states that the body is well proportioned with full flow areas. Heavy body neck prevents distortion and makes a secure bonnet connection and long pipe threads provide leak-tight connections.



The disc holder is of the slip-on type—a turn or two of the handwheel before removing the bonnet prevents disc holder from dropping off. Long guides insure accurate seating. Lugs are provided for wrench hold when removing disc; the beveled extension protects spud threads. Three basic types of discs are offered—steam; hot water; cold water, gas and air. The valves are regularly available in several designs—globe, angle, horizontal and angle check, spring check for compressor service and quick operating. All patterns are described and listed in a recently-issued booklet.

Capacitors for Power-Factor Correction

The Ideal Electric & Manufacturing Company, Mansfield, Ohio, has developed a complete line of capacitors (static condensers) for power-factor correction. These capacitors have an efficiency of 99¾ per cent or better and are characterized by low temperature rise (2 C or less), says the maker.

A feature is the "unit type" construction as these capacitors are an assembly of small independent hermetically-sealed can units. Each unit has been heat-treated and oil impregnated under a vacuum and is provided with fuses sealed in the can under oil.

Box-type capacitors are furnished in welded sheet-steel cases supplied with weatherproof covers and are suitable for either indoor or outdoor service. Rack-type capacitors are generally

[Turn back to page 66]

Heating·Piping
Air Conditioning

NOVEMBER 1933

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Automatic Controls for Forced-Air Heating Systems

By S. Konzo[1] *(MEMBER)* and A. F. Hubbard[2] *(NON-MEMBER)*

Urbana, Ill.

The results presented in this paper were obtained in connection with an investigation of coal fired warm air furnaces and heating systems conducted in cooperation with the National Warm Air Heating and Air Conditioning Association by the Engineering Experiment Station of the University of Illinois, of which Acting Dean A. C. Willard is the Director. This work was carried on in the Department of Mechanical Engineering under the direction of A. C. Willard, Professor of Heating and Ventilation and head of the department, and A. P. Kratz, Research Professor. The results will ultimately be incorporated in a bulletin of the Engineering Experiment Station.

THE principal objects of this study were (1) to determine what particular features are essential to a good control system and (2) to compare the performance characteristics of several different types of control systems and to classify the systems from the viewpoint of satisfactory performance. In all, eleven different control systems have been tested in connection with the coal fired, forced air heating plant in the Research Residence and this study has indicated certain desirable features which any automatic control system must possess in order to insure satisfactory operation of the plant as a whole. From this standpoint, a good control must:

1. Maintain constant and uniform house temperatures for all weather conditions.
2. Be dependable.
3. Be simple in construction and operation.
4. Maintain a uniform combustion rate just sufficient to balance the heating demands on the plant.
5. Handle sudden demands on the heating plant without allowing the furnace temperatures to increase beyond a safe limit.
6. Entail a minimum of adjustment by the home owner.
7. Provide for safety features to check combustion in the event of electrical or mechanical failures.

Description of Plant

All of these tests were run under actual operating conditions on the forced air heating plant in the Research Residence during the winters of 1932 and 1933. The Residence is a three-story structure of standard frame construction and is not insulated or equipped with either storm sash or weather stripping. The total space heated consisted of four rooms and a hallway on each of the first two stories and two rooms and a hallway on the third story, making in all 17,540 cu ft. The heat loss with an indoor-outdoor temperature difference of 80 F was approximately 159,000 Btu per hour, exclusive of the basement loss.

The heating plant consisted of a coal-burning, cast-iron, circular radiator furnace; a duct system consisting of flat rectangular leaders running along the basement ceiling to conventional risers and baseboard registers used in connection with the former gravity installation; and a centrifugal fan, located in the cold air return duct and used for the purpose of forcing the air through the heating plant. The amount of air delivered by the fan during these tests was approximately 1600 cfm, exclusive of a few tests which were run with approximately 2000 cfm. Integrating and indicating wattmeters were placed in the fan motor circuit in order to record the power consumption, and a self-starting electric clock was used to record the total length of time that the fan was actually running during a 24-hour test period. The fan motor used was of the repulsion-induction type.

The fuel burned in these tests was stove-sized anthracite coal, which had a heating value of 13,590 Btu per pound as fired. A few tests were also conducted in which an Illinois bituminous coal of high volatile content was used. Since the operating characteristics when using solid fuels are decidedly different from those obtained when using liquid or gaseous fuels fired intermittently, this paper covers specifically only hand-fired, coal-burning furnace plants.

All of these tests were run on the same heating plant; hence the results were dependent only on the changes made in the control system. In every case, the room thermostat was located in a first story room, at breathing level (5 ft) height.

In the design of the duct system for a forced-air heating plant, the assumption is tacitly made that the fan operation will be continuous and that a constant quantity of air under pressure will be delivered through the duct system. The duct system is then designed so that the short runs have greater frictional resistance to air flow per 100 ft of duct than longer runs in order to equalize the total frictional resistance for all runs. This procedure is directly opposite to that employed in the design and operation of a duct system for all-gravity operation, where the size of first story leaders is larger than that of second and third story leaders for equivalent heat carrying capacities. Since a large number of forced-air plants are operated with the fan running intermittently, with part-gravity flow and with part-fan operation, rather than with the fan running continuously, the dampers in the leaders must necessarily be adjusted to a position that is a compromise between that for all-gravity and that for all-fan operation. If the dampers are set for this medium position, they may not be in

[1]Special Research Associate in Mechanical Engineering, University of Illinois.

[2]Research Graduate Assistant in Mechanical Engineering, University of Illinois.

For presentation at the Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, N. Y., February, 1934.

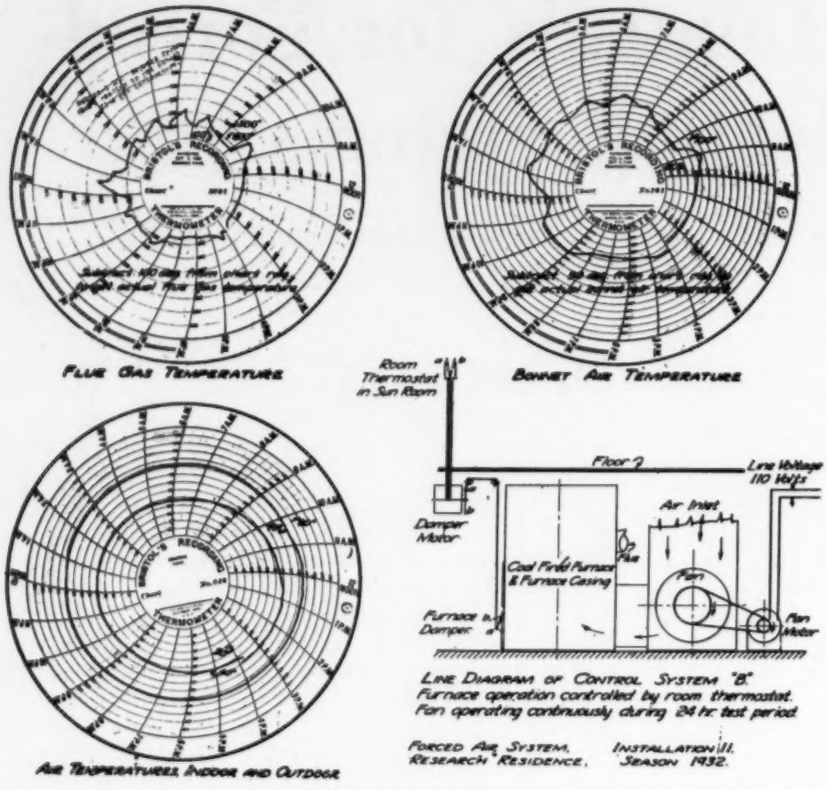

Fig. 1—Room, bonnet air, and flue-gas temperature records for Control Type I

proper adjustment for all weather conditions, and at the extreme conditions of operation may allow unequal temperatures to exist among the different rooms of the house. The use of certain types of controls for intermittent fan operation aggravated this condition, as will be pointed out later.

Performance Characteristics

With the exception of one or two minor variations, the operation of each of the eleven different control installations, which were designated as *A, B, C,* etc., was characterized chiefly by one of four fundamental features, which formed a basis for dividing the controls into the following general types:

Type I: Automatic control of furnace damper operation only, with the fan operating continuously and independently of any control. (Control *B*).

Type II: Automatic control of both the fan operation and the furnace damper operation; so that the fan operated intermit tently, and the damper-open periods occurred irrespective of whether or not the fan was running. (Controls *A, D,* and *I*).

Type III: Automatic control of both the fan operation and the furnace damper operation; so that the fan operated intermittently, except during the damper-open periods when it was rendered totally inoperative. (Control *E*).

Type IV: Automatic control of both the fan operation and the furnace damper operation; so that the fan operated intermittently, and the damper-open periods accompanied either all, or some fraction of each of the fan-on periods. (Controls *C, F, G, H, J,* and *K*).

In the case of Types II and IV the installations which gave the most satisfactory performance were controls *A* and *H* respectively. These have, therefore, been selected as representative of the two types, and in the following discussion only the representative controls have been considered in detail to illustrate the performance characteristics of the four fundamental types and reference to them has been made by type alone.

Type I. (Figs. 1, 2, and 3.) In this case, the room thermostat operated the damper motor directly, and the fan was allowed to run continuously. This arrangement gave a control system that was very simple and dependable. See Fig. 2 for the wiring diagram.

The quantity of air delivered by the fan was practically independent of the bonnet air temperature; consequently, positive and continuous air circulation was maintained, and both the air stratification in the rooms and the resulting room air temperature gradients from floor to ceiling were minimized. Also, for a given adjustment of the volume dampers in the duct system, equal temperatures were found to exist in the different rooms of the house for wide ranges of outdoor weather conditions. The temperature charts in Fig. 1 indicate that the temperatures of the bonnet air, and flue gas were very low. These low temperatures were conducive to a condition of maximum bonnet efficiency and, in view of minimum heat losses from the ducts, of maximum register efficiency. Since the air movement through the register outlets was constant, the register air temperatures were necessarily reduced appreciably in very mild weather, causing perceptible drafts in the vicinity of some of the register outlets.

The temperature charts in Fig. 1 indicate further that the flue gas and room air temperatures tended to over-run slightly after each opening of the furnace damper, but the over-runs were not serious if the room thermostat was sensitive.

The use of a stack limit thermostat, placed in the flue, to close the furnace damper when the flue gas temperature rose to a predetermined value tended to minimize all temperature over-runs. The operating charts in Fig. 3, for a very severe day, illustrate the results obtained with the stack limit thermostat when used in this connection to prevent the flue gas temperature from exceeding approximately 600 F. The fan was operating con-

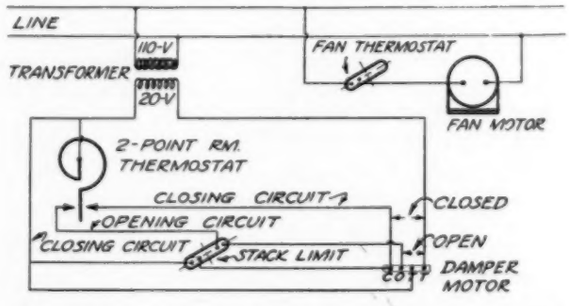

Fig. 2—Wiring diagram for Control Type I. (Stack limit thermostat included)

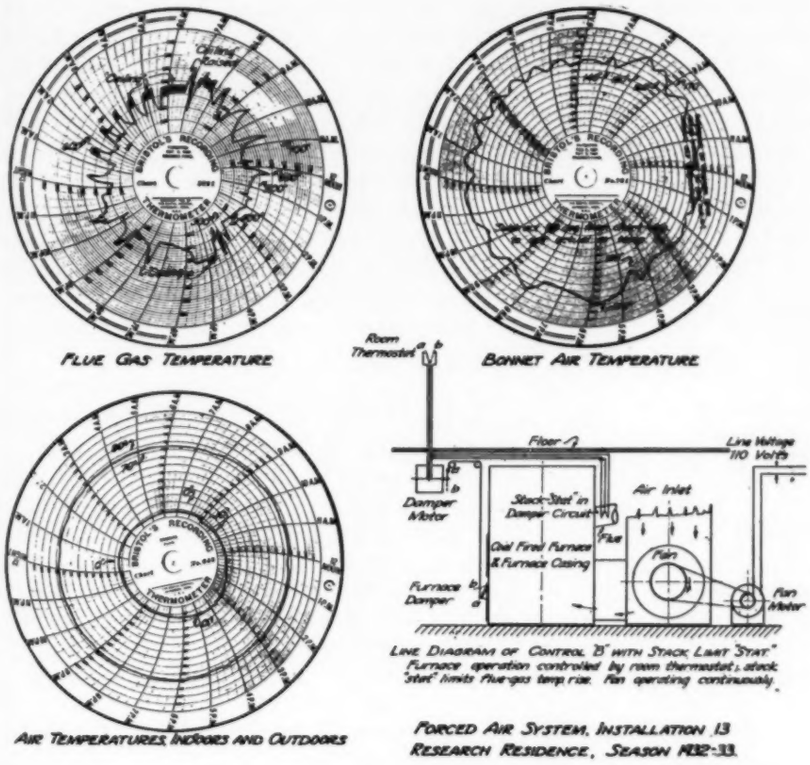

Fig. 3—Room, bonnet air, and flue-gas temperature records for Control Type I, using stack limit thermostat

tinuously, and when the room thermostat demanded heat the damper opened. However, due to the use of the stack limit thermostat, which was set for a temperature high enough to handle the severest weather conditions, a definite *ceiling* was placed on the flue gas temperature. The stack limit thermostat, when used in this connection as an integral part of the control system, was found to be most effective in preventing temperature over-runs, when it was adjusted to conform to the varying weather conditions. Its use in any manner, however, was not absolutely necessary for the successful operation of this type of control system.

Due to the high cost of fan operation with continuous drive systems, the use of controls with intermittent fan operation has been common in connection with forced air heating systems. The three types of systems to be discussed in the following sections were in every case featured by intermittent fan operation.

Type II. (Figs. 4 and 5.) This simply arranged control system consisted of a room thermostat which controlled the operation of the damper motor alone, and an auxiliary thermostat, located in the furnace bonnet, which controlled the operation of the fan alone. The two thermostats were not inter-connected electrically, and each one could be set to operate between any desired temperature limits.

When the room temperature was below normal and the room thermostat demanded heat, the furnace (ashpit) damper was opened and the combustion rate increased. The air temperature in the bonnet was thereby raised and at a predetermined upper limit temperature the fan was started by the bonnet thermostat. The reserve of heated air in the bonnet was soon forced out and the bonnet air temperature was reduced to the predetermined lower limit, depending on the setting of the bonnet thermostat, and the fan was stopped. The periods of *gravity* operation, intervening between the periods of fan operation, were characterized by an increase in the bonnet air temperature. This cyclical operation of the fan continued as long as there was sufficient heat in the bonnet, irrespective of whether the room temperature rose to normal or not. The resulting tendency of the room air temperature to over-run the desired temperature of 72 F was due to this latter effect and is clearly shown in Fig. 4. The temperature chart for the bonnet air shows the very regular, cyclical operation of the fan between two set limits. The sequence of operations is shown in Fig. 5.

With the use of control Type II and for a given setting of the dampers in the duct system, unequal tempera-

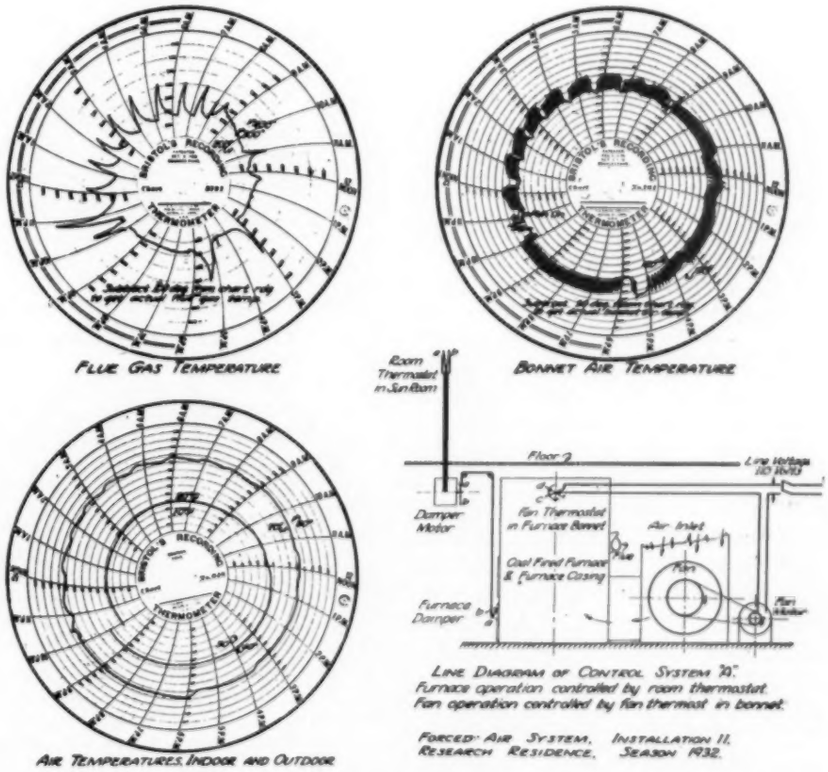

Fig. 4—Room, bonnet air, and flue-gas temperature records for Control Type II

tures were obtained in the different rooms of the house during extreme weather conditions. This condition of unbalance was not serious in mild weather, but in very severe weather, the flue gas temperatures were high and were accompanied by long periods of fan operation. In extreme cold weather operation, therefore, when the fan

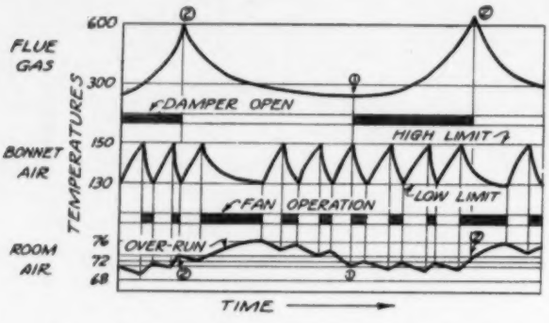

Fig. 5—Sequence of events for Control Type II

tended to run a major proportion of the day, the first story rooms became overheated, and the third story rooms were underheated.

Type III. (Figs. 6 and 7) In the case of control systems of both Type I and Type II, the fan operation was independent of the room thermostat. In the case of control Type III, however, the operation of the fan was controlled by the room thermostat through a fan relay switch, and the furnace damper was operated by a bonnet thermostat. The bonnet thermostat functioned in such a manner that the fan was rendered totally inoperative throughout the periods that the damper was open. The addition of the fan relay switch, together with a more elaborate bonnet thermostat, complicated the control system, but control Type III was as simple as most of the controls using a fan relay switch.

A block diagram accompanies the temperature charts in Fig. 6, and with the aid of this diagram, the cycle of operations may be easily followed from the temperature charts. During the period between 1:00 p. m. and 1:15 p. m., the damper was open for the entire time required for the bonnet air temperature to rise through a temperature differential of approximately 40 F, which corresponds to the differential between the lower and upper limit settings of the bonnet thermostat. During this period, the flue gas temperature rose to a value in excess of 600 F, and the damper was not opened again until two hours later. It would seem logical to assume that if the original setting of the bonnet thermostat had been made so that the furnace damper remained open no longer than the time required to permit the bonnet air temperature to rise possibly only 15 F instead of 40 F, the combustion rate would have been maintained within narrower limits. A bonnet thermostat with this 15 F differential setting was tested and the results were as anticipated. The furnace damper opened more frequently with this thermostat setting, resulting in a decrease in the magnitude of the over-runs in the bonnet air temperature.

Control Type III gave satisfactory operation provided that the setting of the bonnet thermostat was adapted to the heating demands being made on the furnace due to weather changes, and provided that the pick-up in the combustion rate was rapid. When the bonnet thermostat was adjusted for average weather conditions and when the adjustment was left unchanged in milder weather, large over-runs in flue gas and bonnet air temperatures resulted. With colder weather conditions, however, the combustion rate was held below the value necessary to provide for the heating requirements.

Also, for cases in which the pick-up in combustion rate was slow, the room air temperature tended to drop four or five degrees below normal, since the fan was inoperative throughout the pick-up period. This condition is illustrated by Fig. 7. When the bonnet air temperature reached 120 F, as shown by point *3*, the fan stopped and the damper opened. The room air temperature fell from 71 F to 67 F as shown by points *1* and *2*, during the time that the bonnet air temperature rose from 120 F to 160 F, as shown by points *3* and *4*. Here again a bonnet thermostat differential, *d*, of 15 F would give better results than those given by a differential of 40 F.

This system was adapted to handle very sudden heating demands, as in morning pick-up periods, without allowing the furnace damper to remain open long enough to dangerously overheat the furnace. Since the fan was never running after the furnace damper had been

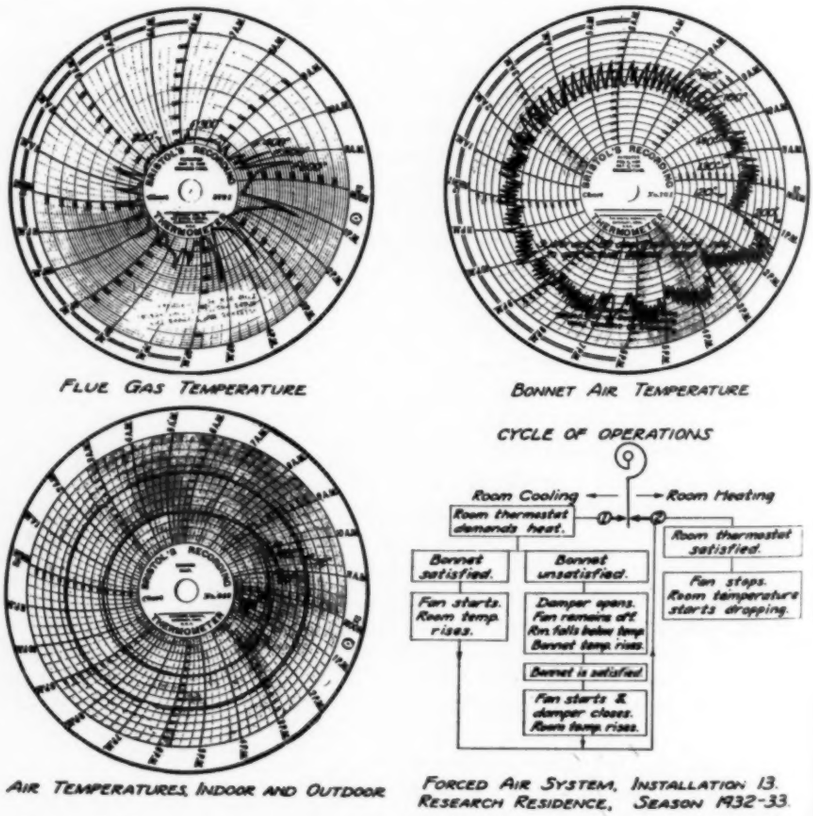
FLUE GAS TEMPERATURE
BONNET AIR TEMPERATURE
AIR TEMPERATURES, INDOOR AND OUTDOOR
CYCLE OF OPERATIONS
Room Cooling
Room Heating
Room thermostat demands heat.
Room thermostat satisfied.
Bonnet satisfied.
Bonnet unsatisfied.
Fan starts. Room temp. rises.
Damper opens. Fan remains off. Rm. falls below temp. Bonnet temp. rises.
Fan stops. Room temperature starts dropping.
Bonnet is satisfied
Fan starts & damper closes. Room temp. rises.
FORCED AIR SYSTEM, INSTALLATION 13. RESEARCH RESIDENCE, SEASON 1932-33.

Fig. 6—Room, bonnet air, and flue-gas temperature records for Control Type III

opened, the bonnet air temperature rose very rapidly to the value at which the bonnet thermostat closed the furnace damper.

Type IV. (Figs. 8, 9 and 10) The results obtained with controls of the types discussed in the foregoing sections had shown that whenever the heating requirements

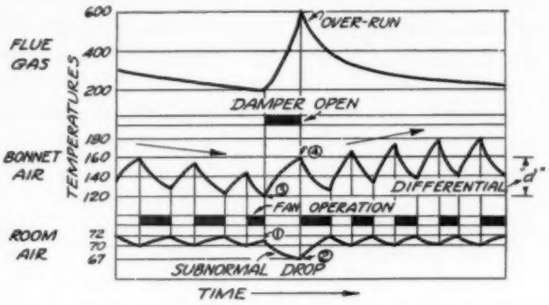

Fig. 7—Sequence of events for Control Type III

of the house were supplied by short periods of rapid combustion followed by long periods of slow combustion, the former periods were followed by more or less serious over-runs in temperature either at the furnace bonnet or in the rooms. Since the furnace casting proper had relatively little capacity for storing heat, the heat that was evolved during the periods of rapid combustion was not held in reserve for gradual use but was rapidly absorbed by the air, with the result that temperature over-runs occurred.

However, the results obtained with a preliminary control arrangement had shown that when the furnace damper was opened frequently and for short periods of time, a much more uniform combustion rate was maintained. The actual operation of this preliminary control was equivalent to the operation of a control system by which the fan operation was controlled directly by the room thermostat alone, and the damper was held open throughout each entire fan-on period. Two significant facts, which had an important bearing on the design of control Type IV, were established by the results obtained with the preliminary control. They were (1) that a uniform combustion rate just sufficient to supply the heating requirements, without great variation from a mean value, could be maintained by allowing the frequency of the damper-open periods to correspond to that of the fan-on periods, and (2) that excessively high flue gas and bonnet air temperatures existed when the furnace damper was open throughout each fan-on period. It, therefore, seemed reasonable that a similar control system which would limit the high flue gas and bonnet air temperatures obtained with the preliminary arrangement would give very satisfactory results.

It was found that the temperatures could be most successfully limited by the use of a control arrangement that would allow the furnace damper to be open during only a part of each fan-on period rather than for the entire period as in the preliminary arrangement. Control Type IV, therefore, was designed (1) to automatically open the furnace damper during each fan-on period, provided that the bonnet air temperature fell below a predetermined value and (2) to automatically adjust the length of time that the damper remained open during each cycle, proportional to the amount that the bonnet air temperature fell below the predetermined value. The first feature provided uniform combustion as a consequence of frequent damper openings, and the second feature maintained a uniform combustion rate just sufficient to supply the heating demand of the house. This latter result was accomplished in the following manner: As the heating demand increased, the heat in the bonnet air tended to become depleted and at the end of each fan cycle the bonnet air temperature assumed successively lower values as represented by points *3a*, *3b*, and *3c* in Fig. 9. This downward trend caused the pick-up period, represented by the distance along the time axis between points *2'* and *3'* to be lengthened, with the result that the combustion rate, as indicated by the flue gas temperature, increased sufficiently to supply the increased heating demand. As the heating demand decreased, the reverse process took place, with the result that the combustion rate was decreased. Therefore, by making the frequency of damper opening dependent on the frequency of the fan cycle, and by making the length of time that the damper remained open dependent on the bonnet air temperature, a very satisfactory control of

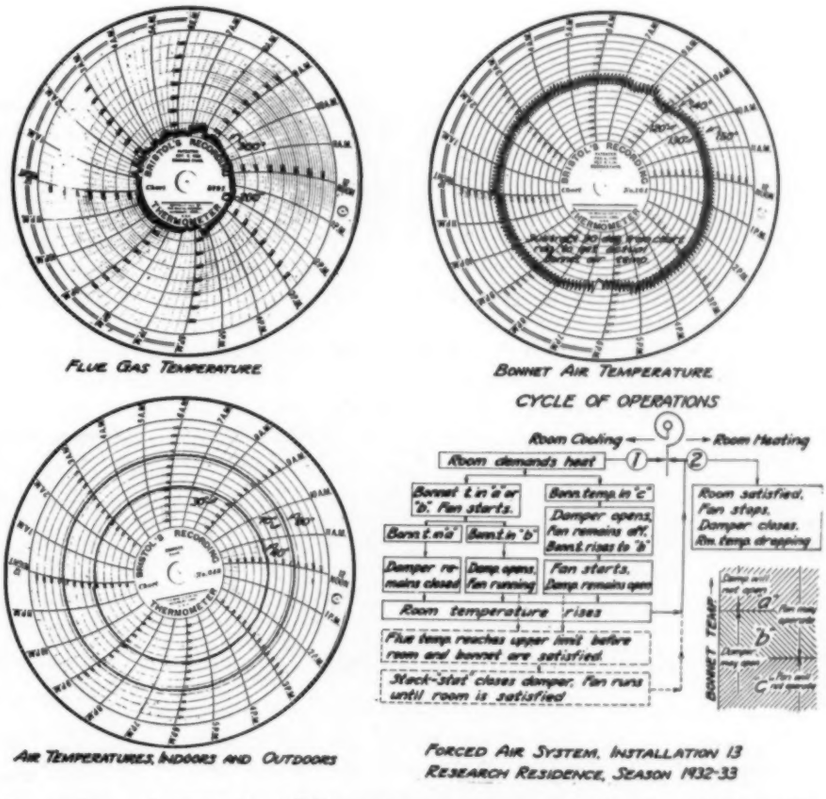
FLUE GAS TEMPERATURE
BONNET AIR TEMPERATURE
CYCLE OF OPERATIONS
Room Cooling
Room Heating
Room demands heat
Bonnet t. in "a" or "b". Fan starts.
Bonn. temp. in "c"
Room satisfied. Fan stops. Damper closes. Rm. temp. dropping
Damper opens. Fan remains off. Bonn. t. rises to "b"
Bonn. t. in "a"
Bonn. t. in "b"
Damper remains closed
Damp. opens. Fan running
Fan starts. Damp. remains open
Room temperature rises
Flue temp. reaches upper limit before room and bonnet are satisfied
'Stack-stat' closes damper. Fan runs until room is satisfied
BONNET TEMP.
AIR TEMPERATURES, INDOORS AND OUTDOORS
FORCED AIR SYSTEM. INSTALLATION 13
RESEARCH RESIDENCE, SEASON 1932-33

Fig. 8—Room, bonnet air, and flue-gas temperature records for Control Type IV

the temperatures throughout both the house and heating plant was maintained.

All of the above features were incorporated in control Type IV by using a room thermostat to control the operation of the fan through a fan relay, a bonnet thermostat to control the furnace damper as explained above, and a damper motor. This equipment was so interconnected electrically that the furnace damper could not open, unless the room thermostat was calling for heat, even though the bonnet thermostat was in the *damper open* position. The manner in which these connections

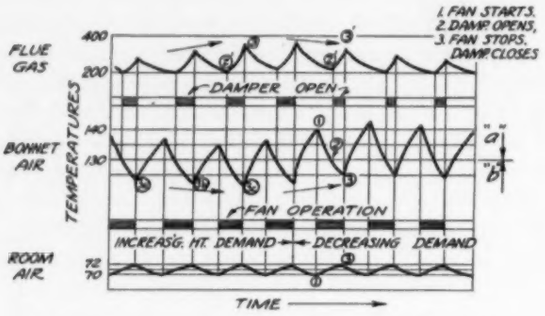

Fig. 9—Sequence of events for Control Type IV

were made is shown by the wiring diagrams in Figs. 10, *a*, *b*.

The temperature records and the block diagram indicating the cycle of operations for control Type IV are shown in Fig. 8. The combustion rate as indicated by the flue gas temperature varied only slightly from a mean value that was just sufficient to supply the heating demands being made on the plant. With only one setting of the bonnet thermostat, equal temperatures were obtained in the different rooms of the house for a wide range of weather conditions. The most satisfactory operation was obtained, however, when the bonnet thermostat setting was adjusted to two values—one value for mild weather and a higher value for severe weather.

In the dotted line portion of the block diagram, mention is made of a stack limit thermostat, which during normal operation did not enter into the operating cycle, except in very severe weather. Its purpose was to limit flue gas temperatures when sudden heating demands, resulting from setting the room thermostat for a higher temperature, were made on the plant. When used in this connection, the stack limit may prove of value not only from the standpoint of safety but from the standpoint of economy as well. Previous tests (see *Bulletin 246*, University of Illinois Engineering Experiment Station, pages 96-101) have shown that the flue gas losses incurred during heavy morning pick-up periods tend very materially to offset the savings resulting from lowering the house temperatures at night. The use of a stack limit thermostat would minimize such flue gas losses.

Comparison of Control Systems

To a certain extent the power consumption of the fan, as measured by the power input to the fan motor, was influenced by the range of bonnet air temperature selected for setting the bonnet thermostat and by the condition of the fuel bed. Both of these factors had some influence on the number of times that the fan was required to operate during one or several cycles of events. As a rule, the condition of the fuel bed was not directly related to the type of control and the effect was a random variable as far as the type of control was concerned. The selection of the range of bonnet air temperature to be used in setting the bonnet thermostat was in some cases dictated by the operating characteristics of the control, and in some cases dependent on the judgment of the operator. In the latter cases it was sometimes a matter of choice between using a range that would permit fairly satisfactory operation over the whole range of weather conditions, and using several ranges of bonnet air temperature best adapted to narrow ranges of weather conditions and changing the setting as the weather varied. All tests were run under conditions considered most reasonably adapted to the control in use, but occasional inconsistencies in power consumption appeared, and it is well to emphasize that in individual cases in practical service the power consumption might deviate considerably from the results obtained in these tests.

The power consumption of the fan in kilowatt-hours per day for various indoor-outdoor temperature differences is shown in Fig. 11-*a*. Some deviations of the points from the curves may be explained by the fact that some variations in the heat load on the house, caused by wind, sun, and rain, can not be expressed directly in terms of indoor-outdoor temperature differences. Most of the deviations, however, were the result of the factors discussed in the preceding paragraph. Hence, the trend of the points has been represented by a mean curve, and by two boundary curves indicating the probable range of deviation attributable to variations in the condition of the fuel bed and in the setting of the bonnet thermostat. With these restrictions, it may

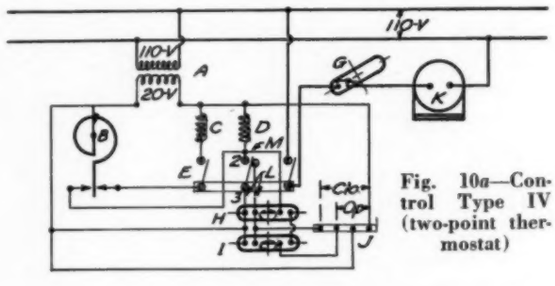

Fig. 10*a*—Control Type IV (two-point thermostat)

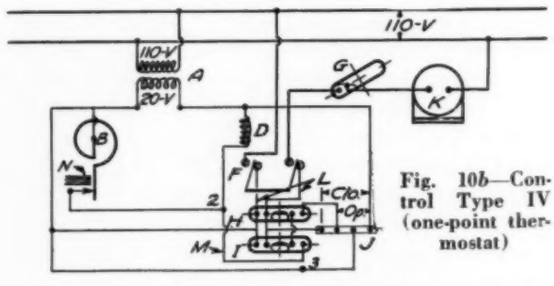

Fig. 10*b*—Control Type IV (one-point thermostat)

A—transformer; *B*—room thermostat; *C*—bucking coil (relay out); *D*—pulling coil (relay in); *E*—4-circuit relay switch; *F*—2-circuit relay switch; *G*—fan thermostat; *H*—bonnet thermostat; *I*—stack limit thermostat; *J*—furnace damper motor; *K*—fan motor; *L*—aux. damper closing circuit; *M*—damper opening circuit; *N*—permanent magnet.
Notes: For Control *F*—omit auxiliary closing circuit marked *(L)*. For Control *J*—omit aux. closing circuit *(L)* and change connection of circuit (M) from point (2) to (3).

be observed that for intermittent operation, the power consumption of the fan motor was more or less independent of the type of control and increased as the indoor-outdoor temperature difference increased. This increase was from approximately 0.4 kilowatt-hours per day at 20 F difference to approximately 3.0 kilowatt-hours per day at 60 F difference. On the other hand, the power consumption for continuous fan operation with control Type I was not greatly influenced by the random factors mentioned and remained practically constant at 3.6 kilowatt-hours per day over the whole range of indoor-outdoor temperature differences. It may be further observed that the power requirements for both continuous and intermittent operation became identical at an indoor-outdoor temperature difference of about 64 F.

The total number of hours that the fan was actually running during a 24 hour test period, as determined by means of a self-starting electric clock included in the fan circuit, is shown in Fig. 11-*b*. At an indoor-outdoor temperature difference of 64 F, at which the power requirements for continuous and intermittent operation became the same, as shown in Fig. 11-*a*, the total number of hours of operation per day was 18 for intermittent operation as compared with 24 for continuous operation. This indicated that for the same number of hours of actual running the fan motor consumed more power when running intermittently than when running continuously. This effect has been attributed to the extra load required to start the motor.

The amount of the extra load imposed by starting the motor is shown in Table 1. The kilowatt-hours per hour of actual running time, was obtained by dividing the kilowatt-hours per day shown in Fig. 11-*a* by the total number of hours of running time shown by Fig. 11-*b*, at the corresponding indoor-outdoor temperature difference. For continuous operation this remained constant at a value of 0.150.

From Table 1 it is evident that in average weather, or at an indoor-outdoor temperature difference of 40 F, the power requirement per hour of running time was 18 per cent greater for intermittent operation than it was for continuous operation. In severe weather, or at an indoor-outdoor temperature difference of 64 F, the starting load constituted an additional load of approximately 30 per cent of the normal running load. The power for starting is influenced by the type of motor and it is possible that if a split-phase or capacitor motor had been used the power for starting would have been greater.

Fig. 11-*c* shows the average number of times the fan was operated per hour in order to maintain the house temperatures, as well as the increase in the number of cycles as the load demand was increased. Under conditions of normal heating demand of the house it was found that a frequency of *fan-on* cycles of between four and eight times per hour gave satisfactory performance.

Table 1—Power Consumption Per Hour of Actual Running Time

Indoor-Outdoor Temperature Difference Deg F	Kilowatt-Hours per Hour		Increase Due to Starting Load Per Cent
	Continuous Fan Operation	Intermittent Fan Operation	
20	0.150	0.155	3
40	0.150	0.177	18
60	0.150	0.190	27
64	0.150	0.196	30

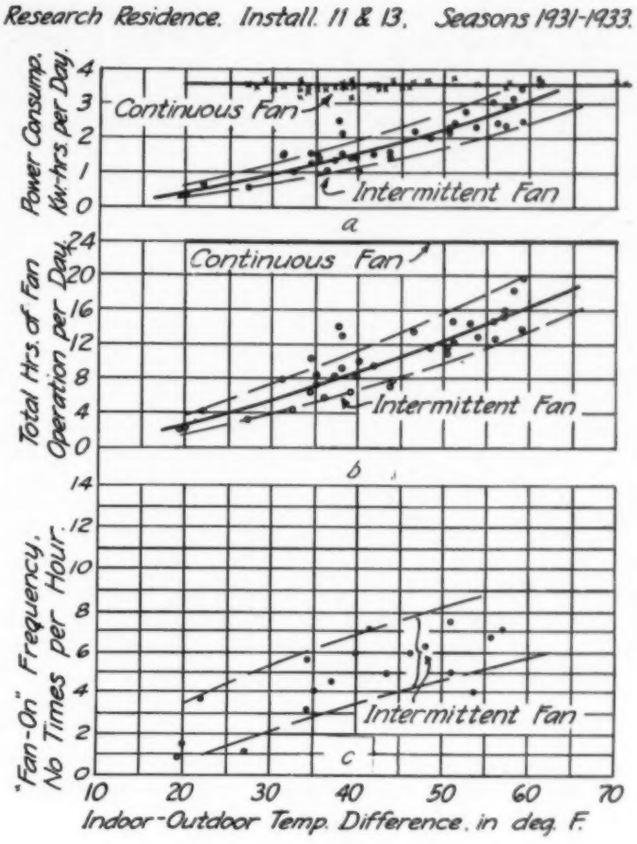

Fig. 11—Fan motor data

Higher frequencies would tend to give closer regulation of the room temperature but the numerous starting-up periods might be detrimental to the fan and motor equipment. On the other hand, frequencies less than four times per hour in normal heating weather did not give satisfactory regulation and equalization of room temperatures.

In all cases of intermittent fan operation, the temperature gradients from floor to ceiling were larger than those obtained in the case of continuous fan operation. During these tests, however, there was no noticeable tendency toward disagreeable air stratification in the rooms.

The results from two years of operation in the Research Residence have shown that there was no marked difference in fuel consumption, or overall house efficiency, with operating methods that varied as widely as the difference between all-gravity and all-fan operation, and further that the fuel consumption was practically independent of the type of automatic control system used. Although the efficiency, as determined by the heat delivered at the furnace bonnet and warm air registers was higher for the all-fan operation, the overall house efficiency, due to the reabsorption into the house of the stray heat losses from casing, ducts, smoke-pipe, and chimney, was not markedly different from that obtained with other methods of operation.

Control Type I had many merits, and in some cases, particularly in large installations, the advantages of continuous fan operation far outweigh the disadvantages. Four suggestions are offered which would overcome to

some extent the chief disadvantages of high cost of continuous fan operation and of low register air temperatures in mild weather:

1. By using suitable diverters in the register outlets, thus tending to spread the air stream and reduce the velocity, or by using high sidewall registers, the flow of air from the registers may be made unobjectionable even for low air temperatures at the register outlet.
2. By providing for an auxiliary fan thermostat in the furnace bonnet, as indicated in the wiring diagram shown in Fig. 2, the fan may be stopped when the bonnet air temperature becomes objectionably low.
3. By suitable design, the plant may be made to operate on register air temperatures of from 160 F to 175 F instead of the 135 F now commonly used, thus permitting the use of a fan with smaller air capacity.
4. By using a two-speed drive on the fan motor, the fan speeds can be regulated to maintain a more uniform register air temperature for all heating loads. The low speed drive would be used for possibly four-fifths of the heating season, and the high speed drive for extremely cold weather only.

With continuous fan operation, satisfactory performance was obtained by means of the simple control equipment commonly used in gravity installations—a room thermostat and a damper motor. With intermittent fan operation, however, the minimum of equipment that could be used included a bonnet thermostat in addition to the room thermostat and damper motor. This minimum of equipment was used in the case of control Type II and the results obtained were not satisfactory, as indicated in the foregoing discussion.

The results obtained with controls Type III and Type IV, on the other hand, show that satisfactory conditions may be maintained in the house with the intermittent fan operation provided that a fan relay switch is incorporated in the control system so that the fan operation may be governed by the room thermostat. The partly satisfactory results obtained with control Type III show that with this combination, frequent adjustment of the bonnet thermostat was necessary to prevent temperature over-runs. Control Type III had one advantage over control Type IV in that when sudden demands were made on the plant, the combustion rate was successfully limited. This advantage, however, was offset by the fact that throughout each pick-up period the fan was totally inoperative, and as a consequence the room temperature fell below normal during these periods.

The very satisfactory results obtained with control Type IV show that it was adaptable to normal operation over a wide range of weather conditions without changes in the initial adjustment. Also, the combustion rate could be successfully limited at all times by the addition of a stack limit thermostat, although it did not become excessively high even without the use of a stack limit. The results obtained with the use of control Type IV, therefore, show that it was possible to obtain results with intermittent fan operation that were as equally satisfactory as those obtained with continuous fan operation without involving the high operating costs characteristic of the latter arrangement.

Conclusions

The following conclusions may be drawn as applicable to the conditions under which the tests were conducted:

1. The room air temperature may best be maintained within definite limits by operating the fan from the room thermostat (through a fan relay).
2. For ideal operation, the operating range of bonnet air temperatures should be governed either manually or automatically, to correspond to the heating demands. A system which tends to maintain a fixed range of bonnet air temperature may be in adjustment to give equal temperatures in the different rooms for a fairly wide range of weather conditions, but for extreme weather conditions this adjustment may result in unequal temperatures in the different rooms.
3. The most satisfactory operation of the heating plant required the maintenance of a uniform combustion rate just sufficient to supply the heating demands being made on the furnace. This requirement involves frequent openings and closings of the furnace damper, and can best be fulfilled when the damper operation is dependent on both the room temperature and the bonnet air temperature. This is equally true for gravity and forced air systems.
4. In systems using intermittent fan operation, uniformity in the length of the cyclical periods of the fan is necessary in order to maintain equal temperatures in the different rooms. Excessively long periods of either fan operation or *gravity* operation may cause overheating in some section of the house apart from the control room.
5. With control systems involving intermittent operation of the fan, the fan should be started between four and eight times per hour in order to obtain satisfactory regulation and equalization of temperatures in the different rooms.
6. Continuous operation of the fan has many advantages, particularly in large installations.
7. The total power required in the case of intermittent fan operation varies from 10 per cent to 100 per cent of the power required for continuous fan operation. In the case of intermittent operation, the power required to start the fan contributes an additional load varying from 3 to 27 per cent in excess of the normal running load, over a range of indoor-outdoor temperature differences of from 20 F to 60 F.
8. The fuel consumption and overall house efficiency for intermittent fan operation and continuous fan operation are practically the same.
9. A stack limit thermostat arranged to prevent flue gas temperatures from exceeding a predetermined upper limit can be successfully used to limit the combustion rate during sudden load demands.

Chicago Council Meeting

The Council of the Society met in Chicago, Ill. on Oct. 25 at the office of John Howatt. Those in attendance were W. T. Jones, Boston, President; C. V. Haynes, Philadelphia, 1st Vice President; John Howatt, Chicago, 2nd Vice President; D. S. Boyden, Boston, Treasurer; Prof. F. B. Rowley, Minneapolis; Prof. G. L. Larson, Madison, Wis.; F. C. McIntosh, Pittsburgh; A. V. Hutchinson, Secretary, New York and by invitation Albert Buenger, Minneapolis; John Hale, and Dr. E. V. Hill, Chicago.

President Jones reported some of the high lights of his visits with the chapters and local groups in Cincinnati, St. Louis, Kansas City, Los Angeles, San Francisco, Seattle, Minneapolis and Milwaukee.

Plans for the 40th Annual Meeting of the Society in New York were approved and it was decided to hold a 1933 Summer Meeting in June in cooperation with the *American Society of Refrigerating Engineers.*

The Code for Professional Engineers was discussed in some detail and the work of the Society's representative John Eadie was commended.

Officers of the Illinois Chapter entertained the Council at luncheon in the Builders Club. The hosts were: Charles W. Deland, J. J. Hayes, J. J. Haines, J. H. Milliken, S. I. Rottmayer.

Heating Effect of Artificial Lighting

By Walter Sturrock* and J. H. Walker †

IT IS a recognized fact that artificial light sources generate heat as well as light. In general, the comparatively small amount of heat from artificial lighting systems in the past has been of very little consequence as far as heating a building is concerned. At present, however, there is a trend in certain classes of interiors toward the use of illumination which requires three, four, or five times the wattage capacity previously used. These higher wattage capacities create a corresponding increase in the heat generated. Also, there is a trend toward the use of artificial cooling systems to provide during the summer months a greater degree of comfort for the occupants of stores, offices, theaters, and other interiors. These trends indicate that in the future more consideration will be given to the heat generated by a lighting system. In this paper the authors discuss the magnitude of this source of heat and its effect in the usual interior as well as in artificially cooled buildings. Also, a discussion is given on the methods of utilizing or dispensing with the heat as may be desired.

In interiors, such as the first floor of a large store building where there is practically no natural daylight, the artificial lighting must be operated continuously during the entire period the building is open for business. On the other hand, in those interiors such as the upper floors of office buildings where artificial lighting is used principally to supplement daylight, the number of hours' use per day varies with the season of the year, greater use being necessary during the winter than during the summer. In both these classes of interiors the heat generated by the lighting units may have a practical value during a greater part of the fall, winter, and spring seasons in our northern latitudes. During the summer months, however, the heat from a lighting system, even though relatively small, may be objectionable in the same manner as is excessive natural heat from the sun.

Energy from Incandescent Lamps

When a gas-filled incandescent lamp of the 300 to 500-watt size is operated at normal voltage its energy distribution is about as follows:[1]

Light	11%
Heat as invisible radiation in the infra-red region	70%
Heat which is conducted away from the filament through the filament supports and leads	3%
Heat dissipated by gas convection and conduction	8%
Heat radiated by the bulb	8%

Hence from a clear-bulb, gas-filled lamp about 90 per cent of the total energy is in radiant form, which includes all of it except that dissipated by the filament supports and leads and by the gas. In burning a bare lamp in an interior its radiant energy will not be effective in raising the temperature in that interior until it has been intercepted by an absorbing surface which in turn will dissipate the heat by convection. The radiant energy will, however, increase the feeling of warmth to the human body by its radiant effect. Practically all surfaces such as building materials, room furnishings, and lighting equipment absorb a part of the wave energy reaching them from a burning lamp. As far as the lighting equipment is concerned the amount of radiant energy intercepted by it will depend upon its type.

One of the most generally used types of lighting equipment is the white glass enclosing globe. If a lamp is placed in one of these units it is estimated that on the average the globe will absorb something of the order of 15 to 25 per cent of the radiant energy reaching it from the lamp filament and nearly 100 per cent of that reaching it from the bulb. Hence with 81 per cent of the total energy generated by the filament of a lamp being set free in the form of radiant energy, then when the lamp bulb is placed in a white glass enclosing globe there will be something of the order of 60 to 65 per cent of the energy dissipated in radiant form. The remaining 35 to 40 per cent of the energy is dissipated from the lamp and enclosing globe by conduction and convection. Theoretically, it is only this heat that can be removed from the lighting unit by a circulating air system and some attention has been given to this possibility in order to reduce the heating effect in a room.

If no attempt is made to intercept and carry away any of the heat generated by the lamp, the question arises as to what portion of it is actually effective in raising the room temperature or in augmenting the load on the cooling system in an artificially cooled building. At first thought it would appear that the heat equivalent of the entire energy input to the lamps amounting to 3.415 British thermal units per watt per hour, must inevitably be regarded as being effective. In fact, that assumption is ordinarily made in the engineering calculations for a cooling system. A close examination of the matter, however, reveals several facts that should modify such an assumption.

It should be remembered that the primary concern is with heat as it affects human comfort, and this may be either in the form of radiant heat or as heat in the surrounding air. Radiant heat which comes from a lighting unit or is re-radiated from the walls or ceiling is instantaneously effective in producing a feeling of warmth. Its effect can be counteracted by maintaining a lower air temperature in a building which is artificially cooled. Not all of the radiant heat from the lamps becomes a load upon the cooling system, however. A portion of it passes through the windows to the out-of-doors and

Abstract of paper presented at the Twenty-seventh Annual Convention of the *Illuminating Engineering Society*, August, 1933.

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[1] *Journal of Franklin Institute*, Vol. 213, No. 6, June 1932, page 623, by W. E. Forsythe and E. M. Watson.

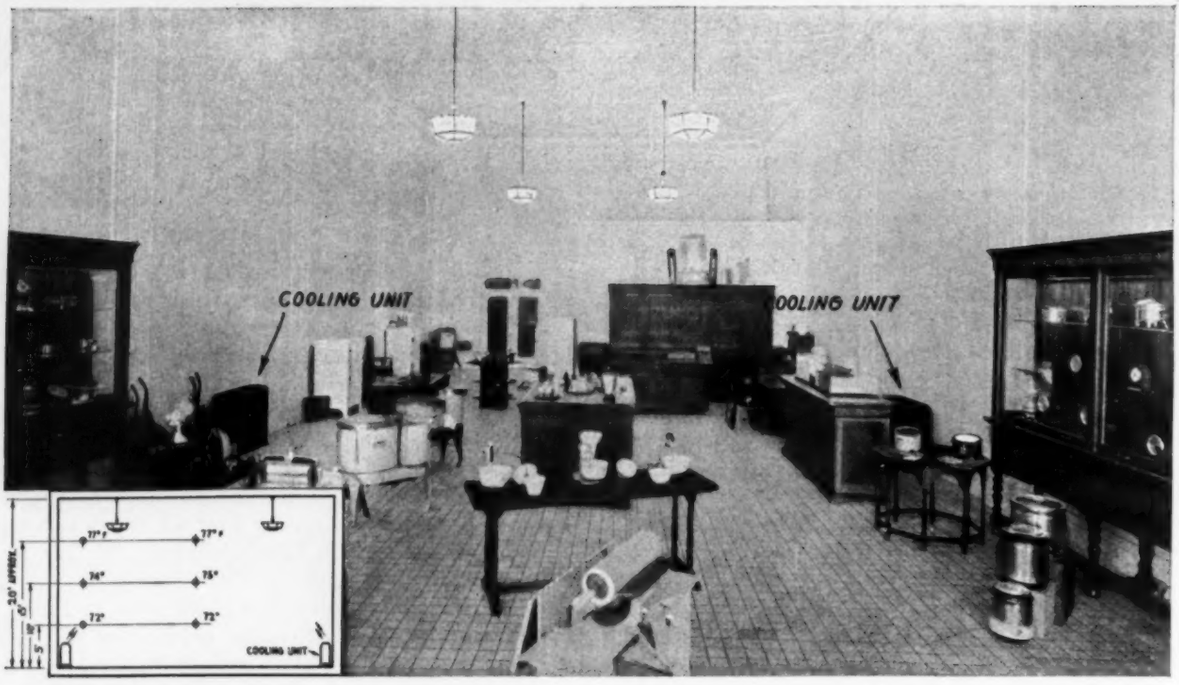


Fig. 1—Interior view of room having cabinet-type air-conditioning units and cross sectional sketch through units showing temperature stratification in room

some of that which strikes the walls, ceiling, and floor is absorbed by the building structure and partially dissipated during the cooler night hours.

The ceiling height of the room has an important bearing upon this matter. The direct radiant heat from the lights will be much more noticeable in a low-ceilinged room because its effect varies inversely as the square of the distance of the human occupants from the heat source. Another effect of the ceiling height is due to stratification of the air. The heat from the lamps which is intercepted by the glassware surrounding them, amounting to 35 or 40 per cent of the total energy of the lamps, goes largely toward heating up the air surrounding the lamp and forms near the ceiling a stratum of very warm air. If this stratification is not disturbed by forced air currents it will not affect the comfort of the occupants below, especially if the room has a high ceiling. If, however, the cooling system is designed to introduce air at high velocity several feet above the floor the stratification is disturbed and the lighting fixtures are swept by the currents of incoming cool air and their heat absorbed by that air, becoming a part of the load on the cooling system.

Consider, however, the room shown in Fig. 1 which has a 20-ft ceiling height and is cooled by floor cabinets placed along the walls. There is a marked vertical gradient of temperature and the cool air currents do not disturb the stratum surrounding the luminaires. This example demonstrates that in a high-ceilinged room, even with artificial cooling, the heat from the lamps may not be entirely absorbed by the cooling system.

Thus it is seen that the process of heat dissipation from the lamp is exceedingly complex and that not all of the energy input is effective in making the room more uncomfortable to human beings or in adding to the load of an artificial cooling system. It is impossible to set up a uniform rule as to how much of the energy input should be considered as load upon the cooling system but each case should be studied from the general viewpoint expressed in the foregoing paragraphs. In the judgment of the authors from *50 to 90 per cent of the lighting energy becomes a part of the cooling load,* depending upon the exact conditions of the installation. The results of investigations on actual room temperature rises in uncooled rooms, due to artificial lighting, throw additional light on the problem.

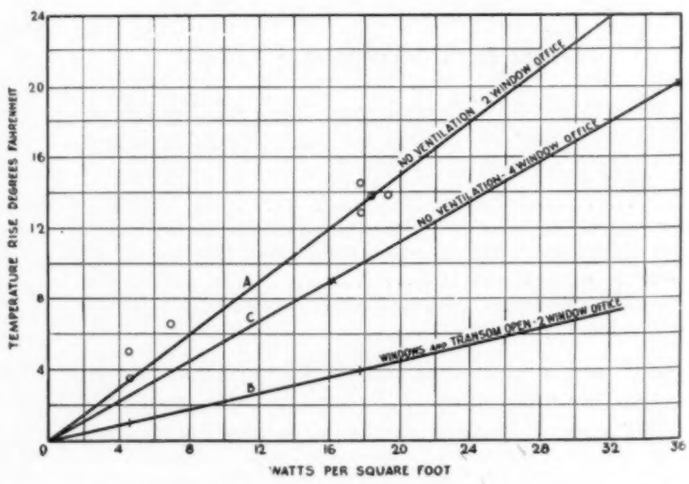


Fig. 2—Relation between the temperature rise during a 7-hour period and the wattage capacity employed for lighting in two typical office spaces

Room Temperature Rises

In order to investigate the relation between the temperature rise and the wattage capacity of the lighting system in a typical commercial office a space was selected in an office building where the lighting capacity could be varied. This particular space had approximately 300 square feet (17 ft by 17½ ft) of floor area with an 11-ft, 9-in. ceiling and had two outside windows, each of which was approximately 3 ft wide and 6½ ft high. The results of the investigation are shown in Fig. 2, Curves *A* and *B*. Curve *A* represents the temperature rise for various wattage capacities of lighting when the room is closed as much as possible by keeping the windows and doors shut. Curve *B* represents the temperature rise on typical summer days when the office is ventilated by raising the lower sash of the windows and opening the transom over the door. For these tests the thermometers were suspended in a vertical position near the center of the rooms with the bulbs three feet above the floor and temperature readings taken for a period of seven hours. By this time a condition of equilibrium was being approached when the heat dissipated from the room was nearly equal to the heat input and there was consequently but little further rise to be expected.

From the curves it will be observed that in the typical closed room with no artificial or natural ventilation the temperature rise during the seven-hour period due to the lighting system is approximately ¾ F for each watt per square foot of electrical energy consumed (Curve *A*). On the other hand, with the windows and transom open for natural ventilation on typical summer days the temperature rise is of the order of 0.22 F for each watt per square foot of lighting capacity (Curve *B*). The lighting equipment consisted of four open-top, semi-indirect units at the ceiling supplemented by indirect floor standards to provide the higher capacities.

Temperature readings in the test room were compared with those observed in an adjacent control room where no artificial lighting was used. The control room temperatures always remained practically constant during the test period. The rise in temperature in the test room was taken as the difference between its initial and final readings, and then this difference corrected to correspond with any change which may have taken place in the control room.

The curves in Fig. 3 illustrate how the temperature in the test room rose with respect to the elapsed time during the seven-hour period when 7 watts per square foot were used (Curve *A*) and when 19.4 watts per square foot were used (Curve *B*). From these typical curves it is noted that approximately half the total rise occurred during the first hour.

The curves in Fig. 4 indicate that the outdoor temperature had very little effect on the test room temperature rise during the seven-hour period when the windows were closed. These curves represent conditions where 18 to 19 watts per square foot were employed (approximately 75 foot-candles of illumination) with outdoor temperatures ranging from 32 to 87 F. Temperature rises of the order of 13 to 14 F were obtained.

On the other hand, with 18 to 19 watts per square foot for lighting the room when the windows were open on a typical summer day the rise in temperature was of the order of 4 to 5 F for the seven-hour period. This is shown by Curve *B*, Fig. 2.

For general lighting throughout interiors such as stores, offices, and factories the electrical capacity in actual use is of the order of 1 to 2 watts per square foot of area. With two watts per square foot it is observed from Fig. 2 that the temperature rise in the closed room is 1½ F while in the ventilated room during the summer time it is only about ½ F. These temperature rises are so small that in the past little notice has been given to the heat generated by the artificial lighting system. In the future, however, even these comparatively small amounts of heat must be considered where air cooling equipment is installed because the equipment must be of sufficient capacity to absorb this heat as well as the natural summer heat. If the building has ample natural light so that little artificial light is needed during the daytime, then the lighting will not constitute an important part of the cooling load. On the other hand, where high intensity lighting is used and the other sources of heat are insignificant, the lighting may be the principal factor.

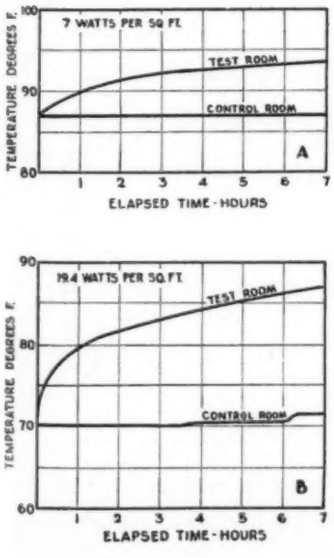


Fig. 3—Characteristic curves indicating that approximately half the total temperature rise for the 7-hour period occurred during the first hour

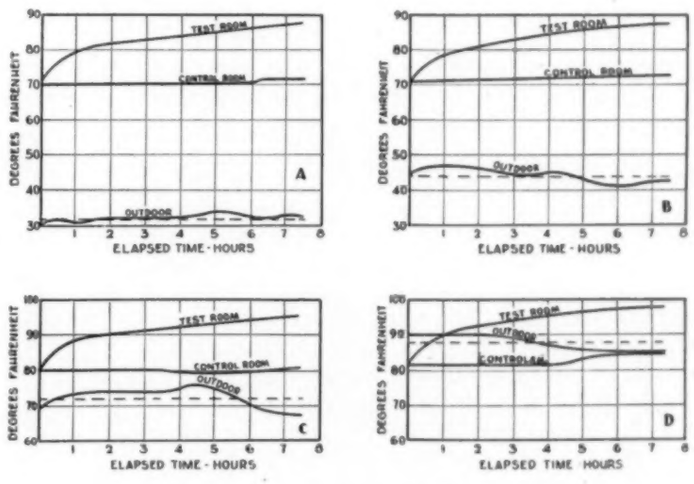


Fig. 4—Curves A, B, C and D show temperature rises when 18 to 19 watts per sq ft capacity was used for lighting and with outdoor temperatures of 32, 44.5, 72 and 87.5 F respectively

In Table 1 is shown the relative importance of the several items which constitute the cooling load in different kinds of buildings. These are figures which were arrived at in the process of designing the cooling systems. The first building in the table is a sales office of an electrical company. The show-windows are not partitioned off from the salesroom itself and the heat from the high-intensity window lighting must therefore become a load on the cooling system. The building is so shaded by adjacent buildings that the sun never shines through the windows and the external load is therefore small. This combination of conditions causes the lighting to be 50 per cent of the total calculated load.

Table 1—Relative Importance of Factors Affecting the Cooling Load in Different Classes of Interiors

Type of Interior	Lighting Watts per Sq Ft of Floor Area		Relative Factors in Per Cent				
	Installed	Assumed in Use	Lighting	Solar Radiation Through Windows	Heat Conducted Through Walls and Windows	Infiltration of Outside Air	Occupants*
†Sales office of electrical company with show-window lighting	6.9	4.4	50	0	2	46	2
Office building:							
With awnings	7.0	3.1	37	0	11	37	15
Without awnings	7.0	3.1	26	33	4	26	11
Cafeteria	0.9	0.9	9	0	6	28	54
Theater		2.6	5	0	5	45	45
†Research Laboratory	2.0	0.7	8.6				

*Includes dehumidifying load.
†Cooling system is in actual operation.

At the other extreme the lighting in a theater is almost negligible as a source of cooling load. The load imposed by the occupants and by the introduction of outside air constitutes most of the total. In the case of the office building the use of awnings eliminates the solar radiation through the windows as a source of load to the cooling system, thus increasing the relative effects of the lighting and other factors.

The figures in Table 1 represent the day of maximum total cooling load, the condition which determines the size of the apparatus. There may be other days, during weather that is less warm, when the load caused by the lighting, though no larger in absolute quantity, is a greater proportion of the total. The figures referring to the lamps are based on the assumption ordinarily made that the entire heat equivalent of the energy input to the lamps which are assumed to be actually in use becomes part of the cooling load. Therefore these figures show the maximum effect of the lighting on the cooling system. It may be said then that the lighting is responsible for a part of the cooling load varying between 5 and 50 per cent of the total, depending upon the type of building. Recognizing this fact leads one to think of ways of eliminating the heating effect from lighting units in some manner such as having the heat diverted directly from the source into a ventilating duct where it will be dispensed with or utilized as may be desired.

Methods of Diverting Heat and Absorbing Radiant Energy from Lighting Units

Circulating Air Through a False Ceiling

In order to take advantage of the natural tendency of heat to rise into higher altitudes, an experimental lighting system was installed which employed four 20-in. enclosing glass globes with hollow fitters connected to openings in a false ceiling. Fig. 5 illustrates diagrammatically the installation which was made in a typical office room. An exhaust fan was used to remove the air from above the false ceiling; the volume of air removed and the temperature rise between the intake and the exhaust air was observed. With a total of 4,163 watts actual consumption at the sockets and with the room closed as regards doors and windows the results of the test are shown in Table 2.

The data from Tests 1 and 2 indicate that about 30 per cent of the Btu's generated by the lighting units can be removed by permitting the heat to rise above a false ceiling where it can be carried away by a ventilating system. Although a greater portion of this heat was removed directly from the lighting unit, yet a small portion of it was no doubt conducted from the room through the beaver-board false ceiling into the ventilating air. It was felt, therefore, that further experimental work must be done to get more accurate and reliable data on the maximum amount of heat which can be removed directly from a light source by circulating air through it, and another series of tests were therefore made, as will be described later.

Table 2— Data and Results Obtained from Tests Conducted in Office (Fig. 5)

				With Chimney Sleeves on Lamps		
Test No.	1	2	3	4	5	6
Change of Air, cu ft/min.	442	342	no change	442	342	no change
Intake Temp., F	80.3	79.4		78.5	82	
Exhaust Temp., F	89.5	90.7		85.5	89.4	
Ventilation Air Rise, F	9.2	11.3		7	7.4	
Btu/min. Removed	72	68.5		54.7	44.8	
Btu/min. Generated	237.3	237.3	237.3	237.3	237.3	237.3
%Btu Removed	30.3	28.9		23.1	18.9	
Test Room Temp. Rise after 7 hours, F	11.4	11.7	10	10.5	11.7	15.6

By removing approximately 30 per cent of the Btu's

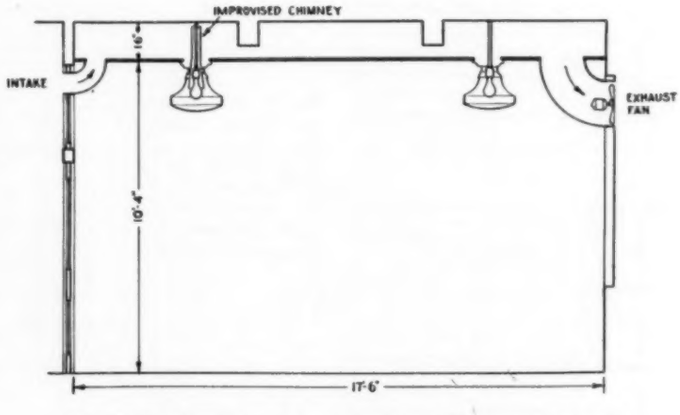


Fig. 5—Cross-sectional view of typical office used in test showing false ceiling with openings above the lighting units and location of intake and exhaust for ventilating air

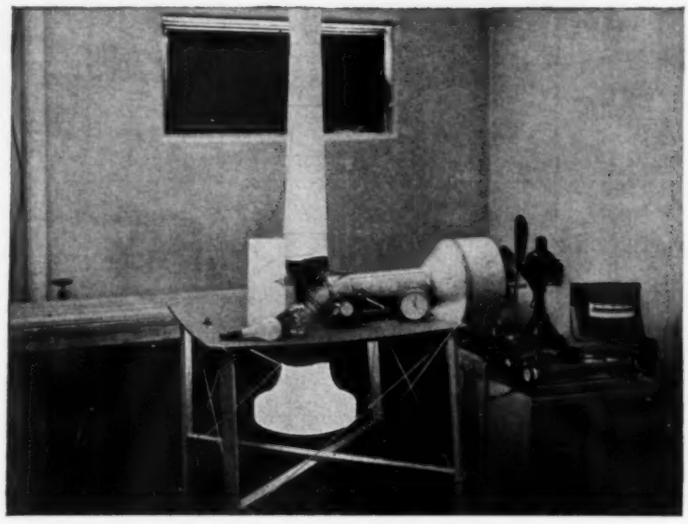


Fig. 6—Arrangement of equipment employed to determine the maximum amount of heat removable by forcing air through an enclosing globe when suspended in a room having a constant temperature

the temperature in the room increased from 80 F to 91.5 F, a rise of 11.5 F, during the seven-hour period. Under similar conditions but without the ventilating system above the ceiling the temperature in the room increased from 69.5 F to 88.5 F, a net rise of 19 deg during the seven-hour period. In this latter test it is believed that the 19 deg rise is 4 to 5 deg higher than it should have been. This belief is based upon the fact that for this particular test the initial temperature was 69.5 deg while the control room registered 75 F. The test should, therefore, have been repeated with approximately the same starting temperature for the two rooms but the equipment was dismantled before the discrepancy was noted. In a majority of the other tests the difference between the starting temperatures of the two rooms was less than 1 F and in no case did it exceed 2 deg.

In attempting to remove heat from the lighting units in the foregoing manner several tests were made with cylindrical and conical-shaped tubes (see Fig. 5) inside the enclosing globes over the lamps to create a greater flow of air upward around the lamp bulbs. The results of this investigation are given under tests No. 4, 5 and 6 in Table 2 which indicate that the flow of heat from the lamp inside the enclosing globe was actually retarded rather than assisted by the improvised chimneys. For example, in comparing the results of test No. 4 with No. 1 it is seen that only 23.1 per cent of the generated Btu's were removed when the chimney was used, while without it 30.3 per cent of the Btu's were removed. The test-room temperature rise was found to be of about the same order in both cases. The opening into the ceiling was 4⅞ in. diameter and when a thin-walled cylinder 3 in. in diameter with conical shaped lower section was placed through it and around the lamp bulb, the resistance to the air flow was apparently too severe to be overbalanced by the theoretically greater draft action which should have been created by the chimney. The cross-sectional area of the chimney was made approximately one-half the total area of the opening so that the air flow would be as free as possible.

Considerable time and effort was spent to determine the most effective size as to diameter and length and the best shape of the chimneys as well as their proper location in the lighting units. On this phase of the investigation the effectiveness of the chimney was judged by observing the temperature at a point on the side of the enclosing globe. The point for observing the temperature was taken about half way down the side of the globe so that none of the various sizes and shapes of sleeves used intercepted the direct radiant energy between the light source and the thermometer. The bulb of the thermometer was fastened in direct contact with the enclosing globe and held in the same position throughout the investigation. Then, for any given condition of ventilation in the room or above the ceiling, temperature readings were taken on two light units, one unit being the control unit and the other one the test unit with the sleeve in it. The readings indicated that different sizes and shapes of sleeves had very little effect on the temperature of the globe assuming a minimum size of sleeve of 3-in. diameter and a sufficient length to extend from slightly below the socket to a point well above the false ceiling.

Tests No. 4 and 5 having forced ventilation above the ceiling show room temperatures about 5 deg lower than test No. 6 which represents a similar test but without forced ventilation.

Maximum Amount of Heat Possible to Remove by Forced Ventilation

As mentioned in the foregoing, it was questionable as to just how much of the approximately 30 per cent heat removed by tests No. 1 and 2 was due to ventilating the lighting units and how much was due to conduction through the ceiling. Further tests were therefore made with equipment such as shown in Fig. 6 to determine the *maximum* per cent which can be removed by circulating air through lighting units of a type and design in general use suspended below a ceiling. This equipment consisted of a 14-in. white glass enclosing globe having a hollow fitter through which intake and exhaust air ducts were brought to the lamp. For the investigation the enclosing globe was suspended in a room where the temperature was held constant while different volumes of air were passed through the globe in which different sizes of lamps were burned. The curves in Fig. 7 show how the ventilating air temperature increased as the volume of the ventilating air decreased for lamps of the 75, 150 and 300-watt sizes. From the temperature rise and volume of the ventilating air the Btu's of heat removed were computed. Fig. *7-B* shows the Btu's removed in per cent of those generated by the lamp for different volumes of ventilating air. It is noted that the three curves in this figure practically coincide when 35 to 40 cu ft per minute of forced ventilation are used. Under this condition it appears impossible to remove by a current of air more than about one-third the total Btu's of heat generated by the lamps. This amount of heat removed checks very closely the theoretical percentage mentioned earlier in this paper.

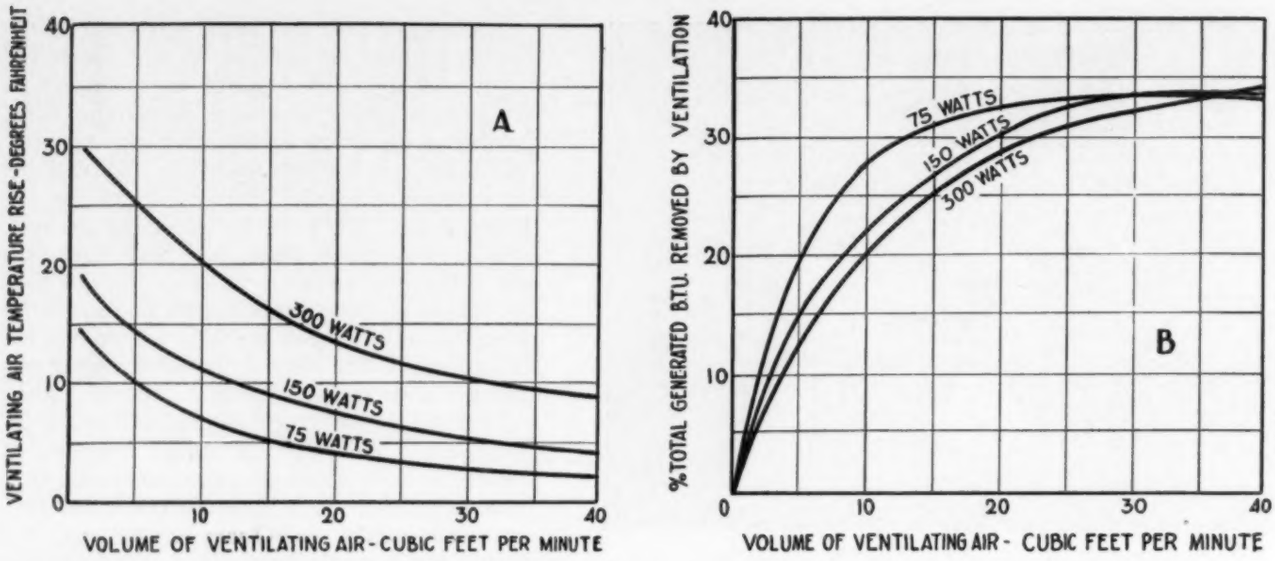


Fig. 7-*A*—(Left) Relation between volume of ventilating air and its temperature rise when lamps of the 75, 150 and 300-watt sizes are used in equipment shown in Fig. 6

Fig. 7-*B*—(Right) Relation between volume of ventilating air and per cent Btu's removed as computed from data curves 7*A*

Another test was made with the equipment shown in Fig. 6 by placing the 14-in. enclosing globe in a cubical box 34 in. on a side as illustrated in Fig. 8. The cubical box was made of masonite ½ in. thick which is a comparatively poor conductor of heat. The object of this test was to compare the air temperatures in the box when the lamp was ventilated with those when not ventilated. Lamps of the 40, 75, 150 and 300-watt sizes were used with approximately 75 cu ft per minute of ventilating air passing through the enclosing globe. In Fig. 9 the solid-line curves represent the temperature rise during a four-hour period when the lamp was ventilated and the dotted-line curves represent the temperature rise during a similar period with no ventilation. A four-hour period of operation was chosen as it was found that it required about this length of time for the temperature in the box to approach a maximum. The data in Table 3 based on temperature readings at the end of the four-hour period indicate that the box temperature was approximately 40 per cent lower when the lamp was ventilated than it was with no ventilation. In other words, if this box could be considered as a small room having masonite ½ inch thick as side walls, floor and ceiling, and no openings (and it is assumed that all the radiant energy must be absorbed somewhere within the room), then it is found that a maximum of approximately 40 per cent reduction in temperature can be obtained by circulating cooled air around the light source.

Table 3—Data and Results Obtained from Tests with a 14-In. White Glass Enclosing Globe in a 34-In. Cubical Box

Lamp Size, Watts	Non-ventilated Lighting Unit Net Temp. Rise in Box, F	Ventilated Lighting Unit (Approx. 75 Cu Ft/Min.)			Btu's Generated per Hour by Lamp	Percentages	
		Net Temp. Rise in Box, F	Temp. Rise in Air Duct, F	Btu's Removed by Air Duct		Temp. Rise in Box. Ventilated to Non-vent.	Btu's Removed to Btu's Generated
300	37.9	22	8	608	1024.5	58.0	59.4
150	20.7	12.3	4.2	326	512.3	59.4	63.5
75	10.5	6.3	2.3	182	256.1	60.0	71.0
40	6.2	4.0	0.85	67	136.6	64.5	49.3
Average						60.5	60.8

Further data from the box tests permitted the determination of the Btu's of heat removed from the lighting unit by the air duct. When approximately 75 cu ft of air per minute were used in the air duct, the temperature rises of the air at the end of the four-hour period are as given in the Table 3. From these data the Btu's per minute removed from the lamp are computed and found to represent approximately 60 per cent of the total generated. This percentage was considerably higher than that found in the previous test for the unit (Fig. 6) when operated in a constant temperature room. This difference was probably due to the abnormal conditions of having the lighting unit confined within the

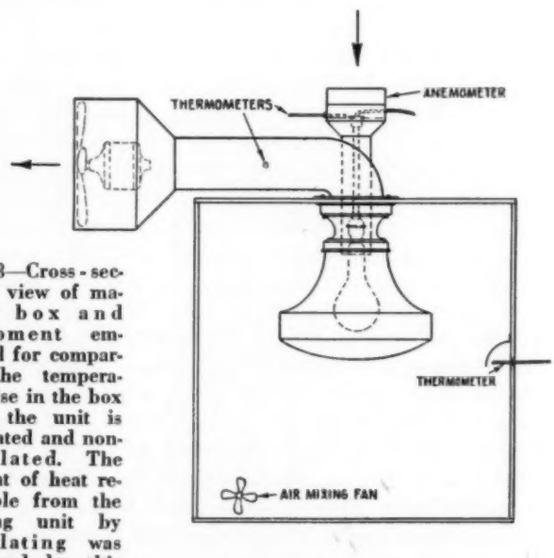


Fig. 8—Cross-sectional view of masonite box and equipment employed for comparing the temperature rise in the box when the unit is ventilated and non-ventilated. The amount of heat removable from the lighting unit by ventilating was measured by this equipment

masonite box where the temperature of the enclosing globe was obviously much higher.

Heat Resisting and Heat Absorbing Media

It is generally known that water will readily absorb practically all the long-wave infra-red radiation, that is, wave-lengths longer than 1.4 to 1.6 microns. On the other hand, water transmits a high percentage of the energy appearing in wave-lengths shorter than 1.0 to 1.2 microns which includes the visible energy. Fig. 10 shows the relative energy at different wave-lengths as generated

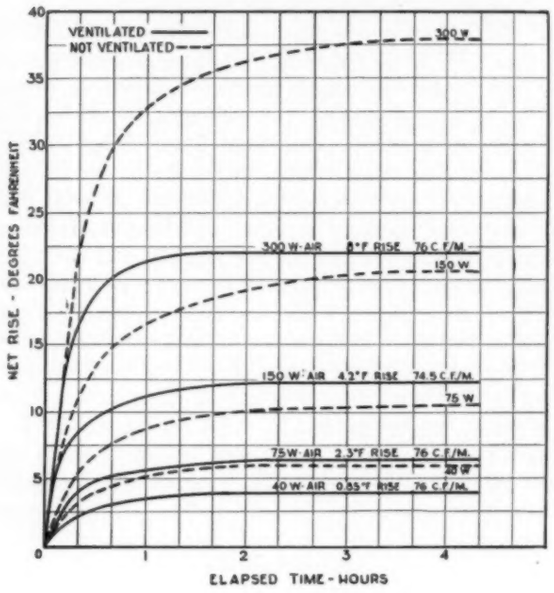

VENTILATED
NOT VENTILATED
300 W
300 W-AIR 8°F RISE 76 C F/M
150 W
150 W-AIR 4.2°F RISE 74.5 C F/M
75 W
75 W-AIR 2.3°F RISE 76 C F/M
40 W
40 W-AIR 0.85°F RISE 76 C F/M
NET RISE - DEGREES FAHRENHEIT
ELAPSED TIME - HOURS

Fig. 9—Curves showing net temperature rises during a 4-hour period in test box with four different sizes of lamps in lighting unit when ventilated and when not ventilated. The temperature rise and volume of ventilating air are also given

by a 500-watt gas-filled incandescent lamp. Superimposed on this curve is a transmission curve for energy passing through 1 centimeter of distilled water. From this it is obvious that lighting units with cold water jackets instead of cold air would greatly facilitate the elimination of heat immediately at the light source. A light source adopting this feature has already been developed.[2]

The unit consists of a distilled water jacket surrounding the lamp and a submerged coil through which cold water is continuously circulated. Tests on such a device employing a 1500-watt projection type lamp indicate that 75 per cent of the radiant energy is absorbed by the water while the sacrifice in total light output is only of the order of 20 per cent; although this method of dispensing with the heat from an artificial lighting system is entirely practical under certain conditions, yet its general application for large interiors appears somewhat remote at the present time.

[2]*Society of Motion Picture Engineers Transactions*, Vol. XIV, No. 3, page 332.

Another medium for absorbing radiant energy from incandescent lamps has been developed[3] in a heat-resisting, heat-absorbing glass designated as Light Shade Aklo No. 396 having a 2-millimeter thickness which it is claimed will absorb 79 per cent of the total energy generated from a 500-watt projection lamp. The light transmission of this special glass is still maintained fairly high, being of the order of 75 per cent. If glass plates such as Aklo could be economically produced, it would appear practical to use them in false ceilings above which artificial lighting systems could be installed. With such a system a circulation of air could be produced to cool the glass plates and thereby have a method of eliminating a high percentage of the radiant energy from a lighting system before that energy is set free in an interior.

Practical Applications

Many lighting systems have in the past been installed with ventilation ducts to carry away the heat. Such systems have always been associated with high levels of illumination, 50 to 100 foot-candles or more, as generally used in display windows, hospital operating rooms and photographic studios. An example of the removal of lamp heat by air circulation is illustrated in Fig. 11. This is a sales office of an electrical company in which the window lighting is of high intensity and the windows are not partitioned off from the sales space as is usually the case. The heat generated by the lamps would therefore be an expensive factor in the cost of operating the cooling system which is installed.

The lighting units are enclosed in metal boxes, each of which has a duct which supplies cool air drawn from the basement. The warm air is discharged to the out-of-doors during the summer when the artificial cooling system is in use. In winter, by a shifting of cut-off dampers, the heat is diverted to the second floor of the building where it is utilized for part of the heating requirements. Means are provided for installing a circulating fan but the gravity circulation alone appears to be sufficient. This installation was made partly for economic reasons in view of the cost of summer cool-

[3]*Corning Glass Works Bulletin*—Glass Color Filters.

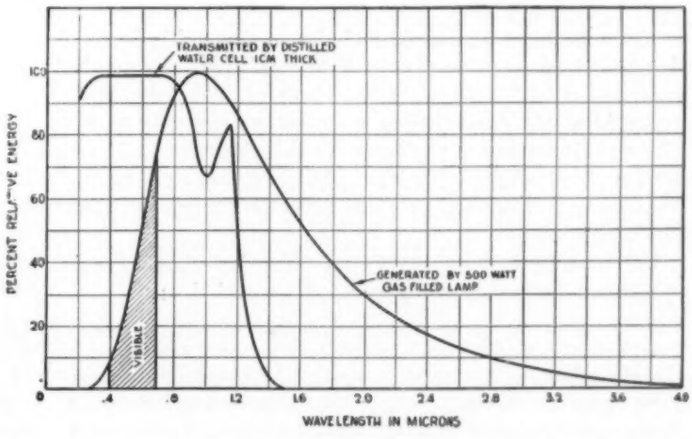

TRANSMITTED BY DISTILLED WATER CELL 1CM THICK
GENERATED BY 500 WATT GAS FILLED LAMP
VISIBLE
PERCENT RELATIVE ENERGY
WAVE LENGTH IN MICRONS

Fig. 10—Relative energy at different wave-lengths from a 500-watt gas-filled incandescent lamp and the per cent of this energy transmitted through 1 cm of distilled water

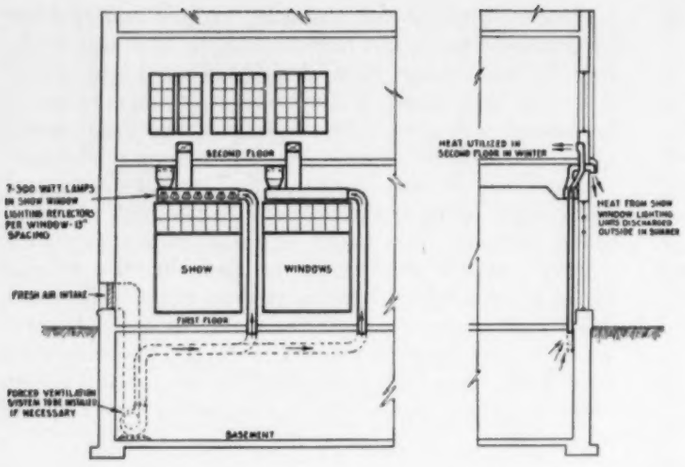


Fig. 11—Sketch showing ventilating system for show-window lighting; dispensing with heat in summer and utilizing it in winter

ing, and partly to permit better control of temperatures during the heating season.

A recent article[4] gave details on a ventilated lighting system in a Philadelphia display room where 40 foot-candles of illumination are used. Quoting from the article—

"Such a large dissipation of heat (15.5 watts per square foot of floor space) presented a problem. If discomfort resulting therefrom had to be prevented by the air-conditioning equipment, a considerable additional investment and operating expense would have been entailed. Consequently a partly closed cylinder of Macbeth heat-absorbing glass was placed around each incandescent lamp, through which air is drawn by a ventilating duct system connected to each fixture. It has been found necessary to run the ventilating fan for at least five minutes after the lights are shut off to avoid breakage of the glass by the sudden storage of heat which would otherwise occur.

"The ventilator withdraws the air from each fixture at the rate of 600 cubic feet per minute, discharging it outdoors in warm weather. When heat is needed in the building the air withdrawn from the fixtures is delivered to the air-conditioning system in such proportions as required. The construction was justified, it is reported, as it cut the cost of the air-conditioning system in half. The steam-heating system is used only on the very coldest days."

Cost Considerations

The foregoing experiments indicate that with forced circulation of air through the lighting fixture the maximum amount of the total heat which could be removed would be about one-third of the total energy generated. The question naturally arises as to whether an auxiliary system of ventilation for the lighting fixtures would be justified on economic grounds in a building which is artificially cooled.

Let us take as an example an office building located in Detroit having the following characteristics:

Height	15 stories
Total net office floor area	102,200 sq ft
Capacity of cooling system	300 tons of refrigeration
Type of cooling system	CO_2 compression system
Hours operation per year	1,000
Initial cost of cooling system	$160,800

[4]*Electrical World*, April 15, 1933, page 480.

Annual operating cost:

Electricity @ 1½c per kwh	$6,130
Water @ 40c per M cu ft	1,920
Total	$8,050

If it is assumed that 35 per cent of the heat from the lamps would be eliminated by the auxiliary ventilation and that, with no awnings on the building, the heat from the lamps would be responsible for 26 per cent (see Table 1) of the capacity of the cooling system and for the same fraction of its operating cost. If then 35 per cent of the lamp heat is removed, the size of the cooling system and the cost of operation would be reduced by 9.1 per cent.

The operating cost would thus be reduced by only $732 per year. The initial installation cost of equipment would not be reduced in proportion to the possible 9.1 per cent reduction in its capacity. Hence the total initial cost of equipment and its installation would be considerably less than (9.1 per cent of $160,800 or) $14,600. The foregoing total savings in cost would probably not be sufficient to pay for the rather complicated system of lighting fixture ventilation which would be required.

Therefore, it appears that removal of the heat from lamps by forced ventilation of the luminaires is justified only when a very large amount of wattage is concentrated so that the ventilation can be done in a relatively simple way or when considerations of comfort in an uncooled building are paramount. Examples of such cases are the high-intensity lighting in show windows, motion-picture studios, and hospital operating rooms.

Conclusions

For lighting systems employing the usual types of luminaires placed below the ceiling, it is mechanically possible to install a ventilating system with air ducts to the units so that a maximum of about one-third the total generated energy can be removed. With the so-called "built-in" types of lighting equipment where a free circulation of air is provided around the lamp, the amount of heat carried off will depend upon the heat transmission characteristic of the glass through which the light enters the room. If this glass is of the heat-resisting heat-absorbing type and is itself cooled, then at least twice as much can be removed by the ventilating air as found possible from the usual types of lighting units suspended below the ceiling.

Buildings Artificially Cooled

In artificially-cooled buildings it is estimated that from 50 to 90 per cent of the total energy generated by the lighting system will eventually become a burden on the cooling load unless this energy or a part of it can be carried off direct from its source. Inasmuch, however, as a maximum of only one-third the total energy can be removed from the usual types of lighting equipment, it is the opinion of the authors that the cost of an auxiliary ventilating system for this purpose would not in general be economically justified for the present standards of lighting whose requirements seldom exceed five watts per square foot of floor area. In other words,

for these general interiors it would be less costly to provide sufficient cooling capacity to offset the heat generated by the lamps as well as that from other sources.

On the other hand, for interiors where high levels of illumination are used which require 10, 15 or more watts per square foot of electrical capacity, careful consideration should be given to a separate ventilating system which not only carries off the readily removable one-third of the heat energy, but also makes use of heat-resisting glass to intercept a considerable portion of the radiant energy.

Buildings Not Artificially Cooled

In general, most buildings in existence are not artificially cooled to create comfort during the summer months. The curves in Fig. 2 indicate that the temperature due to the artificial lighting system in a closed room is of the order of ¾ F for each watt per square foot of electrical energy used. This rise in temperature is not serious for present general standards of illumination, but is of considerable concern when high levels of illumination are used requiring 15 to 20 watts per square foot. In the latter case the temperature rise may be of the order of 10 to 15 F. With the exception, however, of hospital operating rooms, most interiors have natural ventilation obtained from outside windows and doors, in which case the temperature rise on a summer day due to the lighting system is more of the order of ⅕ F for each watt per square foot of electrical energy consumed. This again indicates that it would only be for the higher wattage capacities that any noticeable temperature rise is obtained.

In both the closed room and the one with the windows open there is always for the 15, 20 or higher wattage per square foot installations a large amount of radiant energy from the lighting units. Although this radiant energy does not ordinarily register its presence on the thermometer, yet it creates a feeling of warmth when absorbed by the human body. It is the opinion of the authors that for all interiors where the occupants are working under high-wattage capacities for lighting, more consideration must be given to dispensing with the radiant energy. This may involve the use of heat-resisting heat-absorbing glass or the use of lamps with water cells.

In all the foregoing discussion the problem of removing heat generated by the lighting system is of importance for only three to four months each year. During the other eight to nine months this heat may be of considerable value in contribution to the heating system for the building. It is suggested by the authors that more thought be given by heating and ventilating engineers to this phase of the problem.

The authors wish to acknowledge their appreciation of the assistance given by Mr. W. G. Darley in conducting the temperature tests discussed in this paper.

Annual Report of Michigan Chapter

The Michigan Chapter's annual report has been prepared by Secy. Tom Brown and activities are being carried on under the following officers and committees:

President—H. E. Paetz.
Vice-President—G. D. Winans.
Secretary—Tom Brown.
Treasurer—R. K. Milward.
Board of Governors—Edward Glanz, J. S. Kilner, A. C. Wallich.

COMMITTEES

Speakers and Educational—W. G. Boales, *chairman;* F. J. Feely, *vice-chairman;* L. L. Smith, R. L. Spitzley.
Reception—J. S. Kilner, *chairman;* M. E. Mattingly, *vice-chairman;* E. Harrigan, Jr., C. L. Toonder.
Membership—L. L. McConachie, *chairman;* W. F. Arnoldy, *vice-chairman;* W. J. Hampton, G. H. Waid.

The October meeting of 1932 was attended by approximately 65 members and guests and was in charge of W. G. Boales. He introduced W. G. Malcomson, who gave a very interesting discussion of the Detroit Building Congress. Russell Creviston also gave a very inspiring talk on Business Promotion.

Approximately 50 members and guests attended the November meeting, which was in charge of Tom Brown, who arranged for a very complete discussion of Temperature Regulation. Those who presented papers were: L. H. Kintz, Johnson Service Co.; F. C. Purcell, National Regulator Co.; A. C. Grant, Minneapolis-Honeywell Co.; E. B. Root, Detroit Safety Furnace Pipe Co.; R. D. Randall, Powers Regulator Co., and E. H. Clark, F. I. Raymond Co.

The December meeting in charge of L. L. Smith was a very interesting discussion on Building Trades Relations from Building Owners' Viewpoint, presented by Earl P. Wells, air conditioning engineer of the Union Guardian. There was considerable discussion at this meeting regarding arrangements for the Summer Convention of the Society to be held in Detroit.

The host for the January meeting was the Detroit Edison Co., who served dinner to 95 members and guests and then gave the meeting a most interesting illustrated lecture on Summer Cooling, presented by S. S. Sanford. J. H. Walker and H. E. Paetz were elected representative and alternate, respectively, on the Nominating Committee.

The February meeting was attended by 60 members and guests and was a Winter Frolic held at the Prince Edward Hotel in Windsor, Canada. The evening was turned over to entertainment and general assistance in helping out the depression in Windsor.

The March meeting was cancelled due to the banking holiday

The Chapter was extremely fortunate in having Pres. W. T. Jones address the April meeting which was attended by approximately 30 members and guests.

The May meeting attended by about 50 members and guests was the Annual Golf Tournament and Election of Officers held at the Meadowbrook Country Club. Many golf prizes were awarded and a very enjoyable evening of entertainment was had. Considerable discussion was given to the Semi-Annual Meeting and committees were appointed.

A great number of committee meetings were held previous to the Summer Meeting and a lot of hard work was indulged in by Michigan Chapter members. As to whether or not the Summer Meeting in Detroit was a success, that decision will be left to those who attended.

NOMINATIONS FOR 1934

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1934, submits the following list of nominees:

For President:

C. V. HAYNES, Philadelphia, Pa.

For First Vice-President:

JOHN HOWATT, Chicago, Ill.

For Second Vice-President:

G. L. LARSON, Madison, Wis.

For Treasurer:

D. S. BOYDEN, Boston, Mass.

For Members of the Council:

Three-Year Term

E. H. GURNEY, Toronto, Ont.
W. A. RUSSELL, Kansas City, Mo.
O. W. OTT, Los Angeles, Calif.
M. C. BEMAN, Buffalo, N. Y.

One-Year Term

ALBERT BUENGER, St. Paul, Minn.

Respectfully submitted,

NOMINATING COMMITTEE,

W. R. EICHBERG, *Chairman;*
C. A. PICKETT, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1934:

Three-Year Term

C. A. BOOTH, Buffalo, N. Y.
E. K. CAMPBELL, Kansas City, Mo.
JOHN HOWATT, Chicago, Ill.
A. J. NESBITT, Philadelphia, Pa.
J. H. WALKER, Detroit, Mich.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(a) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

The 40th Annual Meeting of A. S. H. V. E. and the Exposition

Madison Square with Metropolitan and New York Life Insurance Buildings

NEW YORK will be the scene of the Society's 40th Annual Meeting and Hotel Biltmore has been selected as headquarters. Plans for the entertainment program are progressing under the direction of the New York Chapter's Committee on Arrangements headed by Arthur Ritter. Announcement of several committee appointments has been made by Mr. Ritter as follows: *Reception Committee,* Walter L. Fleisher, chairman; *Banquet Committee,* H. B. Hedges, chairman; *Ladies Committee,* Charles Hoffman and Clyde R. Place; *Publicity,* R. B. Purdy.

The Program Committee, of which Roswell Farnham is chairman, has planned for a series of interesting and instructive technical sessions. Papers that have been offered include the following subjects: Electrically Circulated Hot Water Heating; Radiation of Energy Through Glass, Selecting Temperatures and Wind Velocities for Heat Loss Calculations, Automatic Control Systems for Forced Air Heating; Low Cost Air Conditioning for a Small Residence, Atmospheric Ionization; Air Conditioning for Hay Fever, Biological Effect of Health Rays, and Effect of Solar Radiation.

Round trip railroad rates will be available to A.S.H.V.E. members under the Identification Certificate plan. Low rates will be in effect for hotel accommodations and the New York Chapter Committee on Arrangements is planning a program of entertainment that will appeal to everyone.

Registration will commence on Monday morning Feb. 5 and the first session will be called to order by Pres. W. T. Jones at 2:30 p. m. Technical Sessions will be held each day and plenty of time has been allotted to see the Heating and Ventilating Exposition and the sights of New York both in daylight and at night.

The 40th Annual Meeting will be a big meeting, an interesting meeting and one that will be remembered for years to come. This is the objective of the New York Chapter members who will be hosts. Don't miss it.

The Exposition

From Feb. 5 to 9 inclusive the Third International Heating and Ventilating Exposition will be held in Grand Central Palace, New York City, and indications are that the variety and size of exhibits will surpass the earlier successful displays in Cleveland and Philadelphia.

This year, with renewed interest in public building projects in line with the government program of industrial recovery, practically all of the exhibitors are planning special features in connection with their displays and the tendency will be toward animation in exhibits which will not only draw attention of the audience, but will better inform them of the practical points of operation according to C. V. Haynes, Chairman of the Advisory Committee. An idea of the comprehensiveness of the Exposition may be gained from the fact that it will bring together hundreds of exhibitors, including the leading industrial organizations, showing the latest and best equipment for heating and ventilating, and for air-conditioning. There will be heaters and burners designed to operate with gas, oil, solid fuels, and electricity; also fans, air filters, humidifiers, unit heaters, and unit coolers. Heat insulating materials and new products in the field of refractories, noise eliminating devices, and electrical operating and control devices will be featured. These will constitute a large group of the valuable accessories which are utilized in making homes and office buildings proper places in which to live and work, regardless of the weather.

Notwithstanding the impetus given by present public building projects, and the renewed interest in private construction contracts, it has always been characteristic of heating and ventilating that this industry does not depend wholly on new building construction. There is always an immense field or market in the remodeling of existing structures, and in the replacement of obsolete equipment with facilities of more modern design. Studies have shown that there is a point at which it is more economical to replace old equipment than to continue its wasteful operation. Then too, a building which is structurally sound, and well located, becomes a much better income producer through rentals, when its advantages include the types of heating and ventilating equipment which are among the talking points of the newest buildings.

The Third International Heating and Ventilating Exposition will embrace a number of separate sections devoted to specific phases of the total subject. Thus while there will be a section devoted to the heating and ventilating industry in general, there will be separate sections devoted to oil heating, gas heating, warm air heating, and refrigeration and cooling.

The latest developments in boiler design, vacuum heating systems, circulating hot water systems, air filters, and noise filters will demonstrate to owners and operators, both of buildings and homes, the best kind of equipment and the best type of fuel for their particular conditions. Unit heaters will be featured extensively, as will be domestic automatic stokers. There will be fans and blowers of every description, and chimney dampers which are automatically controlled. A series of pumps designed for unusual efficiency and flexibility in the handling of fluids will be on view, and there will be a wide variety of valves, fittings, and radiation surfaces.

Not only the production of conditions of temperature and air circulation are important, but these must be indicated, recorded, and controlled. Consequently the sections devoted to instruments of precision will be unusually complete with representative devices to indicate or record instantly, or continuously, such factors as temperature, pressure, volume, time, velocity, and draft.

The Show will be worthwhile—don't miss it.

Local Chapter Reports

Illinois

October 9, 1933. The Illinois Chapter held its annual meeting and dinner at the Hotel Sherman with an attendance of 46.

Pres. J. H. O'Brien called the members to order and appointed H. M. Hart, J. D. Small and A. G. Sutcliffe as tellers to count the ballots for Officers and Board of Governors for the coming year.

The secretary, J. J. Hayes, then read the annual report of the Board of Governors.

Other committee reports were submitted by the respective chairmen as follows and were approved by vote of the members: Auditing Committee by C. W. Johnson; Finance Committee by J. H. Milliken; Better Relations Committee by J. J. Aeberly; Membership Committee by R. E. Hattis; Legislative Committee by J. H. O'Brien; and Meetings and Publications Committee by C. W. DeLand.

The result of the election was reported by the tellers, who stated that 62 ballots had been received and that 8 were invalid:

President—C. W. DeLand.
Vice-President—R. E. Hattis.
Secretary—J. J. Hayes.
Treasurer—J. H. Milliken.
Board of Governors—G. H. Blanding J. J. Haines, S. I. Rottmayer, H. R. Linn.

Applications for membership were received from T. F. Hanley, Jr., J. J. Hayes and M. I. Weil, who were welcomed into the Chapter.

The speaker of the evening was Samuel R. Lewis, Consulting Engineer, whose subject was Code of Fair Competition for the Professional Engineer. Mr. Lewis' talk was prefaced by a few remarks by John Howatt, Second Vice-President of the A. S. H. V. E., on the National Recovery Administration and its code of fair competition for industry, for labor and for the consumer.

After this brief introduction, Mr. Howatt turned the meeting over to Mr. Lewis, who presented a clear and concise synopsis of the Code of Fair Competition for the Professional Engineer Division of the Construction Industry.

A few of the important points made by Mr. Lewis were: (1) Membership regulations of the A. S. H. V. E. are almost identical with those of the *A. S. C. E.*, which is the sponsoring body; (2) The code is to apply to all engineers who are engaged in construction work and insofar as possible, to meet all the requirements of the NRA; (3) Article III contains the mandatory provisions of the NRA and tends also to safeguard the professional standing of engineers; (4) Article IV covers the relations between engineers and their clients; (5) Article V covers unfair practices; (6) Article VI provides for the administration of the code by a National Control Committee.

An interesting and lengthy discussion followed Mr. Lewis' talk and was participated in by many of the Chapter members and guests.

President O'Brien then turned the gavel over to the newly elected president, Mr. DeLand, and introduced the new Officers and Board of Governors to the membership.

President DeLand's forceful and pertinent remarks presage a very successful year for the Illinois Chapter.

The meeting adjourned at 10:15 p. m.

Michigan

October 4, 1933: The first meeting of the year opened at the Detroit Golf Club in the form of an outing and dinner with 80 members and guests present. Arrangements were made by F. J. Feely, who acted as host.

The roll was called by Pres. H. E. Paetz, who gave the names and business affiliations of those present. Announcement was then made of the committees appointed to date and their personnel.

The treasurer's report was given by R. K. Milward of the funds turned over to him by E. H. Clark, including the proceeds from the Semi-Annual Meeting of the Society.

A motion was made by Mr. Whalen, seconded by Mr. Nannen, that the following resolution be adopted:

Resolved, that Section 1, Article 5 of the Constitution and By-Laws be amended for the meeting year 1933-34 to the effect that annual dues shall be reduced from $5.00 to $3.00 payable in October, 1933.

This motion was passed.

A motion was made by R. L. Spitzley, seconded by Thomas Chester, that the following resolution be adopted:

Resolved, that Section 1, Article 1 of the Constitution and By-Laws, Heading of Officers, be amended to read four governors, three to be elected and the fourth to be the retiring president of the preceding year, with the understanding that this resolution be placed in effect this year.

This motion was also passed.

Dispensing with further business, President Paetz introduced C. V. Haynes, Philadelphia, Pa., 1st Vice-President of the Society, who gave a very instructive talk to the Chapter. Mr. Haynes spoke about the Annual Meeting in New York next February with headquarters at the Hotel Biltmore and further advised that practically all space for the Heating and Ventilating Exposition to be held at Grand Central Palace in connection with the Annual Meeting has been taken. He mentioned that the Summer Meeting might possibly be a joint meeting with the *American Society of Refrigerating Engineers* and would probably be held in Pennsylvania. He stressed the point that the employment blanks forwarded to members should be filled out by any of those interested and returned to the National Secretary at once. Since January 1, he advised that 175 new members have been added making a present membership total of 1819.

President Paetz then read a very interesting letter from one of the most enthusiastic older members of the Michigan Chapter, Ralph Collamore, who was unable to be present due to illness.

The toastmaster of the evening was then introduced and was none other than former national treasurer of the Society, Cecil W. Farrar, of Buffalo, N. Y., who greeted the Chapter with his usual clever stories and introductions. He called upon several present to comment on the Society and its activities, among whom were J. R. McColl, past president of the A. S. H. V. E.; J. F. McIntire, member of the Council, who congratulated the Chapter on the manner in which they conducted the Summer Meeting; R. L. Spitzley, past president of the *Heating and Piping Contractors National Association,* who stressed the point that everyone must do his own part for the Society if he is to get anything out of it; J. H. Walker, chairman of Research Finance Committee; L. L. Smith, NRA Code Representative of the Michigan Chapter; Tom Brown, secretary of the Michigan Chapter; and N. J. Hill, engineer, who gave some very interesting experiences of his recent work in Russia.

Mr. Farrar then read a letter to the Chapter from the National President, W. T. Jones, which contained some very good advice for the coming year. Mr. Farrar introduced W. A. Rowe, past president of the Michigan Chapter and former Council member, who spoke about Research Activities and the TRANSACTIONS of the Society. He was followed by E. E. Dubry, past president of the *National District Heating Association* and a former Chapter president.

A motion was made by Tom Brown and seconded by G. D. Winans that a rising vote of thanks be extended to Mr. Feely for his hospitality. The motion was carried unanimously.

L. L. McConachie was called upon for some remarks regarding the Membership Drive and then made a motion that a rising vote of thanks and appreciation be extended to Messrs. Haynes and Farrar for their splendid cooperation in making the first meeting of the year such a huge success. The motion was seconded by F. D. Cooper and unanimously passed.

The meeting adjourned at the usual hour of 10:00 p. m.

Philadelphia

October 12, 1933: Following a very good dinner at the Engineers Club, the membership of the Philadelphia Chapter adjourned to the auditorium where the meeting was called to order by Pres. M. F. Blankin.

Minutes of the May meeting were read and approved, as were also minutes of a special meeting held Sept. 21, 1933, to consider the proposed Engineers' Code.

The treasurer's report was approved as read and a representative of the United Campaign addressed the members in connection with a Welfare Drive soon to be started.

The meeting was then turned over to the chairman of the Meetings Committee, W. F. Smith, who asked Morris Sheffler, a member of the committee, to introduce the speaker of the evening.

J. C. Albright was presented and gave a very interesting and instructive paper, illustrated with slides, on Atmospheric Water Cooling Equipment. A discussion followed, led by R. V. Frost, during which Mr. Albright answered many questions.

President Blankin then asked R. P. Schoenijahn, a past president of the Chapter, to express to Mr. Albright the members' appreciation for his address.

President Blankin called for nominations for a Nominating Committee of five to select officers for 1934. Mr. Smith offered the following names, which upon motion were seconded by A. J. Nesbitt: L. C. Davidson, *chairman*, S. E. Plewes, J. D. Cassell, A. A. Miller and G. W. Barr. The motion was unanimously approved.

Secy. W. R. Eichberg was called on as chairman of a special committee to consider the Engineers' Code and reported that his committee had met and forwarded to A. V. Hutchinson, secretary of the A. S. H. V. E., their objections to several parts of the Code.

F. D. Mensing, who had been at Washington during the public hearing, gave his reactions to the Code as filed very clearly and instructively.

The meeting consisting of approximately 60 members and guests was then adjourned.

Pittsburgh

October 16, 1933. The Pittsburgh Chapter held its first monthly meeting of the 1933-34 season in the auditorium of the U. S. Bureau of Mines with 35 members and guests present when Pres. G. S. McEllroy called the meeting to order.

The minutes of the May meeting were read and approved and H. B. Orr, treasurer, presented his report.

L. B. Pittock, chairman of the Program-Publicity Committee, announced that at the November meeting one of the best known architects in Pittsburgh, C. T. Ingham, would tell the members w' at an Architect Thinks of a Salesman. Everyone was urged to attend this meeting both for pleasure and instruction.

President McEllroy appointed the following Nominating Committee and requested them to present nominations at the November meeting for Officers and Board of Governors: F. C. McIntosh, chairman, F. A. Gunther and F. H. Hecht.

An appeal for new members for both the national Society and the Chapter was made by President McEllroy, who stressed the fact that many organizations formerly concerned with low powered refrigeration are now entering the air conditioning field and that men in this w rk should affiliate with the Society. It was also requested that members pay Chapter and Society dues.

Mr. Gunther presented the guest and speaker, George Fisher, Pennsylvania State Archeologist, who spoke on The Mound Builders of Western Pennsylvania. Although this subject was a departure from customary talks on heating, piping and air conditioning, the audience indicated by their enthusiastic reception that an occasional evening of popular nature is well received by a technical group.

After lengthy and enjoyable discussion full of skeletons and bones, Mr. Fisher was given a rising vote of thanks in appreciation of his talk.

St. Louis

October 4, 1933: Pres. C. A. Pickett called the members of the St. Louis Chapter to order at the Kings-Way Hotel, where a meeting was held preceded by dinner.

The chair requested nominations for the Nominating Committee and L. W. Moon was proposed by Paul Sodemann and seconded by E. A. White as chairman of this committee. J. M. Foster was nominated by E. E. Carlson, seconded by O. H. Wolff and E. A. White was proposed by J. W. Cooper, seconded by G. W. F. Myers. The chair appointed R. M. Rosebrough and E. B. Evleth to complete the Nominating Committee of five members.

The proposed Code of Fair Competition for Professional Engineers was discussed and the secretary, C. R. Davis, read a letter from A. V. Hutchinson, secretary of the Society, on this subject.

It was announced that an application for membership had been received from Paul Edward Seepe.

President Pickett introduced W. T. Jones, Boston, Mass., president of the A. S. H. V. E., who addressed the Chapter on the Status Quo of the Society.

President Jones presented a very enlightening and detailed account of the activities of the Society and very definitely proved that every member received more from the Society than he could possibly put into it. The talk was greatly appreciated by the 29 members and guests present and was followed by a discussion from the floor.

There being no further business, the meeting was adjourned.

Western New York

October 9, 1933: The first gathering of the season was held at Gandy's with 20 members present for dinner and 35 at the meeting which followed.

Pres. D. J. Mahoney announced the nomination of M. C. Beman for a three-year term on the Council and extended to him the Chapter's best wishes in this work.

W. F. Johnson spoke of the recent illness of Roswell Farnham and called attention to the fact that he had not missed a local meeting since the Chapter's inception. It was then voted to have the secretary, W. E. Voisinet, write Mr. Farnham, giving him credit for being present at the meeting and expressing the well wishes of the Chapter.

Mr. Beman then presented the speaker of the evening, A. J. Slade, who spoke on District Heating.

Correction

Because of an unfortunate shifting of type in the October issue, the references for two candidates for membership appeared incorrectly. They should have appeared as follows:

BURNS, ROBERT, Htg. Engr., Ochiltree Elec. Co., Pittsburgh, Pa.	G. S. McEllroy L. B. Pittock	F. A. Gunther J. L. Blackshaw
HOLLISTER, NORMAN A., Air Cond. Engr., 7101 Colonial Road, Brooklyn. N. Y.	F. R. Still Arthur Ritter	J. I. Lyle W. L. Fleisher

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 17 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by November 15, 1933, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
AHLBERG, HENRY B., Engr., Chase Brass & Copper Co., Erskine Radiator Div., Waterbury, Conn.	H. F. Hutzel James Holt	A. V. Hutchinson
BLISS, GEORGE L., Engrg. & Sales, Allis-Chalmers Mfg. Co., Kansas City, Mo.	E. K. Campbell	David Caleb
BRODERICK, EDWIN L., Research Asst. in M. E., University of Illinois, Urbana, Ill.	D. D. Zink	E. K. Campbell, Jr.
	A. P. Kratz	M. K. Fahnestock
	A. C. Willard	S. Konzo
BURBAUM, W. ALLEN, Asst. Br. Mgr., Rex Cole, Inc., New York, N. Y.	J. W. Hunter (*A. S. M. E.*)	K. E. Quier (*A. S. M. E.*)
	R. B. Dale (*A. S. M. E.*)	N. W. MacKenzie (*A.S.M.E.*)
CHRISTIE, ALFRED Y., Salesman, U. S. Radiator Corp., Boston, Mass.	L. A. Brissette	E. A. MacDonald
	I. S. Dane	Leslie Clough
DAVIS, ROBERT J., Dist. Sales Engr., B. F. Sturtevant Co., Seattle, Wash.	S. D. Peterson	P. M. O'Connell
	W. W. Cox	W. E. Beggs
DUNBRACK, ALVIN P., 172 Arlington Ave., Jersey City, N. J.	R. B. Dale (*A. S. M. E.*)	C. B. Jones (*Non-Member*)
	C. E. Toole (*Non-Member*)	J. L. Eqilernd (*Non-Member*)
ENGEL, EDWARD, Design Draftsman, Hull Div., U. S. Navy Yard, Philadelphia, Pa.	E. E. Brady (*Non-Member*)	T. F. Kelley (*Non-Member*)
	H. C. Robinson (*Non-Member*)	W. G. Alcorn (*Non-Member*)
HAUAN, MERLIN J., Consulting Engr., Seattle, Wash.	W. W. Cox	P. M. O'Connell
	S. D. Peterson	W. E. Beggs
KACZENSKI, CHESTER, 1102 Third Ave., New York, N. Y.	O. W. Kothe (*A. S. M. E.*)	F. N. Sandford (*Non-Member*)
	Alex Cameron (*Non-Member*)	
KNOPF, CHARLES, 1201 Liberty Ave., Brooklyn, N. Y.	J. W. Hunter (*A. S. M. E.*)	H. P. Miller (*A. I. E. E.*)
	A. L. Cook, (*A. I. E. E.*)	C. C. Carr (*A. I. E. E.*)
LEUPOLD, H. W., Engrs. Helper, Metropolitan Life Insurance Co., New York, N. Y.	J. W. Hunter (*A. S. M. E.*)	K. E. Quier (*A. S. M. E.*)
	R. B. Dale (*A. S. M. E.*)	N. W. MacKenzie (*A.S.M.E.*)
METZGER, A. F., Junior Engr., Allegheny County Steam Htg. Co., Pittsburgh, Pa.	G. S. McEllroy	F. A. Gunther
	L. B. Pittock	A. V. Hutchinson
MOORE, ROBERT E., Salesman, Sarco Co., Inc., New York, N. Y.	R. B. Dale (*A. S. M. E.*)	J. W. Hunter (*A. S. M. E.*)
	K. E. Quier (*A. S. M. E.*)	N. W. MacKenzie (*A. S. M. E.*)
MURRAY, JOHN J., Vice-Pres., Pierie Perry Co., Boston, Mass.	L. A. Brissette	W. F. Gilling
	Adolph Ehrenzeller (*Non-Member*)	Leslie Clough
PARSONS, R. A., Sales Engr., Dail Steel Products Co., Lansing, Mich.	O. D. Marshall	H. B. Dirks (*A. S. M. E.*)
	L. G. Miller	H. B. Huffaker
RATHBUN, PERRY W., Inspector, U. S. War Dept., Ft. Sill, Okla.	A. W. Parker (*Non-Member*)	Carl Wallace (*Non-Member*)
	Robert Carlisle (*Non-Member*)	Ray Fisher (*Non-Member*)

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBER

BURNS, ROBERT, Htg. Engr., Ochiltree Elec. Co., Pittsburgh Pa.

EGGLY, HARRY J., JR., Consulting Engr., Philadelphia, Pa.

HOLLISTER, NORMAN A., Air Cond. Engr., 7101 Colonial Rd., Brooklyn, N. Y.

ASSOCIATE

COLCLOUGH, OTHO T., Custodian, Legation of the U. S. A., Ottawa, Canada.

JUNIOR

RYAN, WILLIAM F., Sales Engr., Lee Hardware Co., Salina, Kansas.

Multiple V-Belt Drive Announcement

ALLIS-CHALMERS Manufacturing Company, of Milwaukee, Wisconsin, announces that licenses under United States Letters Patent No. 1,662,511 relating to power transmitting mechanism, commonly known as Multiple V-Belt Drive, have been granted to the following belt and sheave manufacturers:

The American Pulley Company	Philadelphia, Pa.
The Dayton Rubber Manufacturing Company	Dayton, O.
R. & J. Dick Co., Inc.	Passaic, N. J.
Dodge Manufacturing Corporation	Mishawaka, Ind.
L. H. Gilmer Company	Tacony, Philadelphia, Pa.
Goldens' Foundry & Machine Company	Columbus, Ga.
The B. F. Goodrich Rubber Company	Akron, O.
The Goodyear Tire & Rubber Company, Inc.	Akron, O.
W. A. Jones Foundry & Machine Company	Chicago, Ill.
The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc.	Passaic, N. J.
The Medart Company	St. Louis, Mo.
The Ohio Valley Pulley Works	Maysville, Ky.
Pyott Foundry & Machine Company	Chicago, Ill.
Rockwood Manufacturing Company	Indianapolis, Ind.
T. B. Wood's Sons Company	Chambersburg, Pa.
Worthington Pump and Machinery Corporation	Harrison, N. J.

Allis-Chalmers Manufacturing Company

Milwaukee, Wisconsin

for Most *Efficient, Economical* Air Conditioning Insulation . . . . *Specify* CORINCO

Air Ducts insulated with Corinco Corkboard and Lagging

Corinco Insulation is vitally essential for air-conditioning systems. For the equipment is efficient and economical only when the cold or warm material which it carries is delivered to the points where desired with the minimum loss of cold or warmth. It is necessary also because when the materials carried through the pipes and surfaces are colder than the dewpoint of the air that surrounds them, and not properly or adequately insulated, then the resulting dew will cause damage.

Further, where conditioned air is used to maintain certain temperatures in manufacturing processes, no unnecessary chances can be taken to permit impure air or condensation to permeate through the unprotected parts of the air-conditioning system and affect the room temperature and accordingly the uniformity of the products made.

Corinco Corkboard and Lagging has been accepted as the ideal protector of air-conditioning equipment and ducts from unconditioned air entering the system. In many of the most important air-conditioning installations throughout the country, Corinco was used because of its absolute imperviousness to moisture and its enduring dependability.

It will pay you to learn more about the utility and economy advantages of Corinco. Our branch engineer, in your territory will gladly confer with you, without obligation. We invite your inquiry.

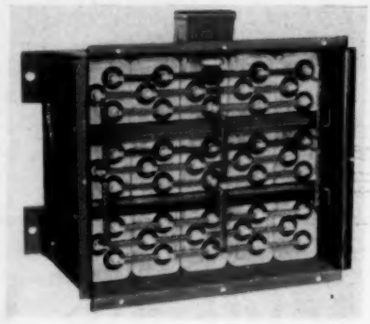
CORK INSULATION CO., INC.

155 EAST 44th STREET NEW YORK, N.Y.

BRANCHES IN PRINCIPAL CITIES

Factory—Wilmington, Del.
Manufacturers of Sheet Cork—Cork Pipe Covering—Granulated Cork

[From page 570]

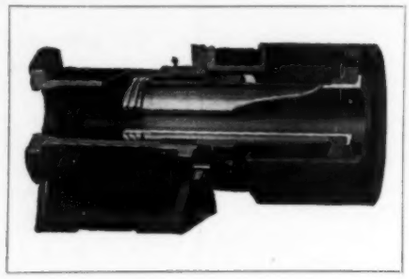


employed in sizes over 30 kva and are supplied in a weatherproof housing or with heavy steel screen enclosures for indoor use. The illustration shows a capacitor with cover removed to show the unit construction.

The capacitors are made for all voltages up to 4600 volts, for any frequency and phase arrangement, and in any size desired.

New "Piston Ring" Expansion Joint

A patent has been granted to Robert Hall, President, American District Steam Company, North Tonawanda, N. Y., on a new design of slip-type expansion joint and has been assigned to his company, according to a recent announcement. Through an adaptation of the piston-ring idea, similar to that used in gas engines, the line pressure in steam or other piping equipped with the new piston-ring expansion joint is retarded in reaching the stuffing box. This permits complete repacking of the joint, if necessary, while the line is under full pressure.



A small relief connection with suitable valve is made into the body of the joint, between the piston-ring head and the stuffing box so that the pressure which builds up in that area can be quickly relieved, if and when new packing is required. The piston-ring arrangement prevents the steam in the line from escaping during any such temporary period. The guide head in which the piston rings are retained also serves as an internal guide operating in the machined cylinder of the body to prevent any lateral distortion of the slip, and the stop ring prevents the slip from pulling out of the body. This expansion joint is now being made available for all operating pressure and all pipe sizes.

Oil Burner for Process-Steam Boilers

The rotary-flame oil burner illustrated here has been developed by Charles E. Reed & Co., 3227 Carroll Ave., Chicago, for use with high-pressure boilers generating small quantities of steam as used by dairies, bottlers, breweries, tailors, cleaners, etc. It is also adapted to hot-water tanks, heating small residences, etc.

The burner is a forced-draft type with gravity oil feed, has a flame rotary in motion, very flat, and intensely hot, according to the manufacturer. It operates on the high-low principle, and on low fire will burn six hours or more on one quart of No. 1 oil, it is stated; on high fire it has a capacity up to 1½ gallons per hour.

There are no moving parts in the firepot. A fan directly attached to a 1/100-hp motor comprise the only moving parts. The fan and motor are totally enclosed in a cast housing with an air inlet and adjustment so arranged that the incoming air flows around the motor to keep it cool. Standard equipment includes the necessary controls. The burner is attractively finished in black enamel.

Steel Heating Boilers Up to 3900 Sq Ft

A new steel heating boiler for use in smaller institutional, business, and public buildings requiring boiler capacities up to 3900 sq ft has been made available by the Fitzgibbons Boiler Company, Inc., 570 Seventh Ave., New York City. Compactness is one of the features; the largest size will pass through a 31-in. doorway, and the medium and small sizes are less than 28 in. in extreme width. The water-line is low, permitting installation in rooms of ordinary height without the necessity of excavating for a pit.

Other features mentioned by the manufacturer include large-size doors and openings to allow quick and easy accessibility in installing oil burners and stokers; extra large door at front of boiler, allowing fire tubes to be cleaned with convenience; a mechanism built into the boiler which balances draft and saves fuel. An auxiliary grate is optional equipment with oil-fired types. Provisions for heating service water either with or without the use of a storage tank can be incorporated. A recently-issued bulletin describes these boilers in detail and gives rating tables.

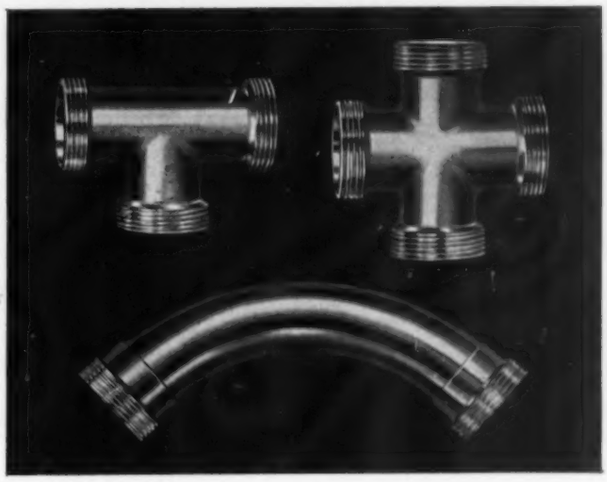
New Mercury-Switch Thermometer Controller

The use of mercury switches to eliminate open make-and-break contacts controlled by the pen arm, is a feature of a new automatic control thermometer announced by The Brown Instrument Company, Philadelphia, Pa. In this controller, every six seconds a motor-driven control table determines the location of the pen on the chart in reference to the control setting, and tilts the mercury switch from one side to the other if the temperature has changed. With this system, the measuring mechanism is free to position itself, unhampered by the control mechanism, says the maker. The making of control contacts is not dependent upon friction, because the switch is positioned with a positive action by the electric motor. Contacts are unaffected by vibration because the mercury switch is mechanically locked in place until a different position is required. The mercury switches have capacities up to 15 amperes at 110 volts (10 amperes at 220 volts), eliminating external relays in most applications.

This control mechanism is adaptable to one-, two-, or three-contact control (or signalling) systems. In a two record controller, each control mechanism can control a separate device, each may be used independently of the other, and each has its own control index. The controller is also supplied as a time-temperature cycle controller. A transparent cam placed over the chart is used to shift the control index in relation to time. As the cam rotates with the chart, the control point is moved to new positions, depending upon the shape of the cam. A different cycle of control operations can be obtained by simply cutting a new cam.

All models of this controller are furnished in circular 10-in. or 14-in. dust-proof cases. It is equally adaptable for control of pressure, liquid level, and similar factors, as well as temperature. A catalog completely describing this line of controllers is available.

PITTSBURGH PIPING
Fabricators of
STAINLESS STEEL



HAVE you considered the advantages of stainless and special alloy steels?

Everywhere your attention is directed to alloys—their longer life and greater strength point the way to savings.

Are you taking advantage of the possibilities of these special steels bv putting them to work in your plant?

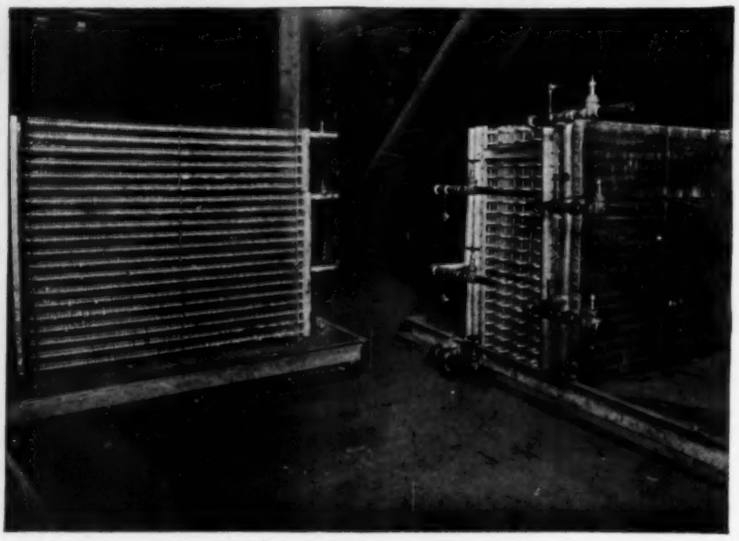
PITTSBURGH PIPING & EQUIPMENT COMPANY, specializing in welded fabrication, is able to supply any special stainless alloy equipment to your specifications.

Let us quote on your requirements.

PITTSBURGH PIPING & EQUIPMENT CO.
43rd ST. & A. V. R. R. PITTSBURGH, PA.
BRANCH OFFICES
NEW YORK INDIANAPOLIS
CHICAGO SAN FRANCISCO
DETROIT CLEVELAND
BOSTON HOUGHTON, MICH

For Large or Special Fin Coils

See BUSH

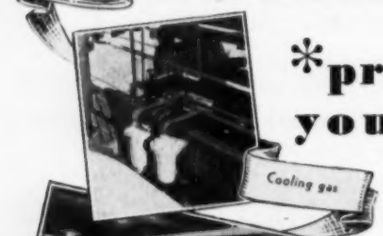


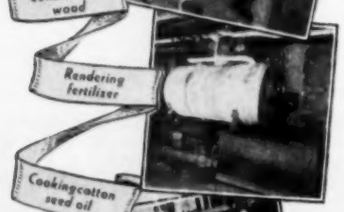
Each of the coils shown has 1380 lineal feet of tube and 3408 square feet of surface. They are used to cool the fermenting and storage rooms of a modern brewery.

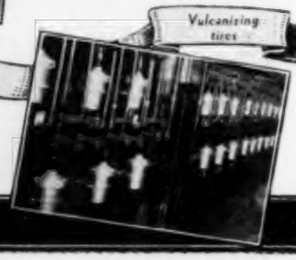
The Bush Mfg. Co. specializes 100% on fin coils and would appreciate the opportunity to quote on your requirements.

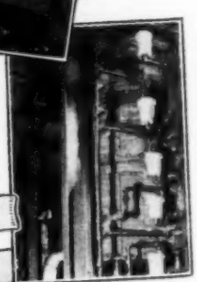
THE BUSH MFG. CO., HARTFORD, CONN.

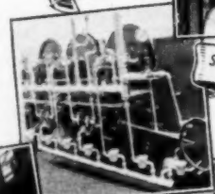
ARMSTRONG STEAM TRAPS

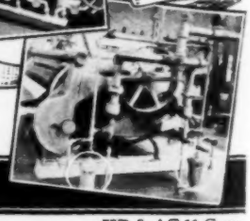












***process the steam that you use in processing**

* Processing steam by an Armstrong steam trap means simply the automatic removal of the air and condensate from the steam, thereby permitting it to perform its maximum work of transferring heat.

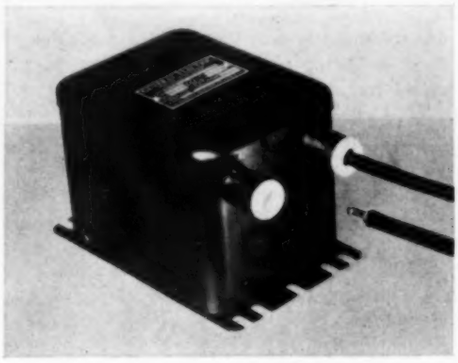
ARMSTRONG MACHINE WORKS

874 Maple St. Three Rivers, Michigan

HP & AC 11 Gray

Ignition Transformer for Oil Burners

According to an announcement from the General Electric Company, Schenectady, N. Y., a positive and reliable source of ignition for oil burners is offered in its new radio-interference-proof transformer. The design of this equipment is planned



to simplify assembly with the burner and minimize possibility of accidental contact and shock because each high-voltage terminal consists of a receptacle with a removable plug arranged for soldering to insulated cable. Provision is made for attaching, directly to the transformer, flexible conduit for surrounding the high-voltage cable.

The new transformer is not only balanced electrostatically, itself, but, in addition, makes it easy to install the remainder of the high-voltage ignition circuit with practically perfect electrostatic balance, says the announcement. Under this condition, radio-frequency oscillations generated by the spark do not enter the primary supply lines, but pass directly to ground through the neutral connection. Balancing of the circuit also reduces considerably the stress on the transformer insulation caused by the radio frequency voltage which might otherwise be detrimental.

These transformers are available in either 10,000-volts or 12,000-volts, the former meeting normal requirements of oil-burner ignition, and the latter the most severe requirements, such as burners which use heavy grades of fuel.

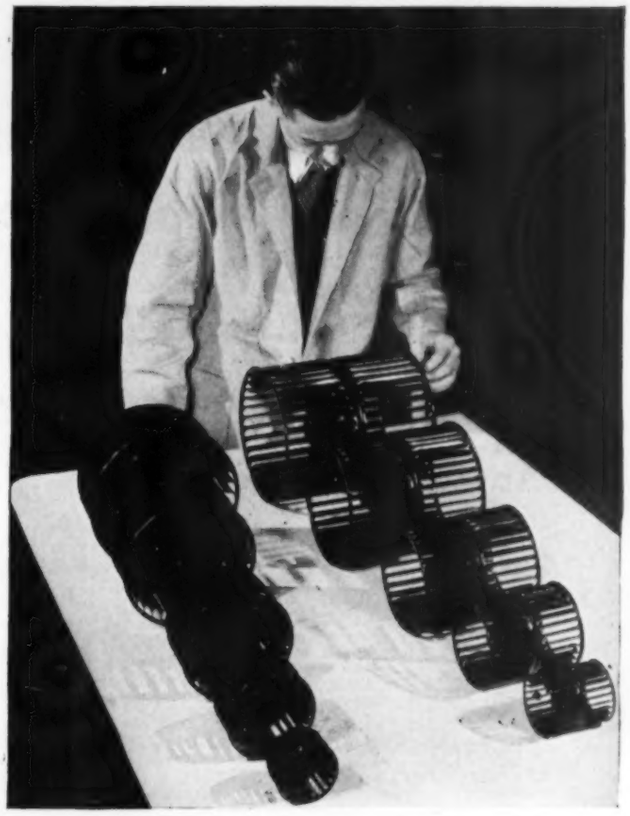
High-Strength Silicon Bronzes

The silicon bronze alloy "Duronze" made by the Bridgeport Brass Co., Bridgeport, Conn., has recently been supplemented by "Duronze II" and "Duronze III." Silicon is used as an alloying element to increase strength, improve resistance to fatigue, and to make the bronzes more inert to corrosive attack. "Duronze II" was developed to meet requirements for a strong hot-forging alloy which should at the same time have fair cold-working properties; it is supplied in rod, wire, sheet, and plates. It is recommended by its makers for the manufacture of hot-water storage tanks, gasoline tanks, vats and boilers used in the chemical and sugar industries, flues and ducts in air-conditioning equipment, ducts for corrosive fumes from battery rooms and from plating and dip rooms in factories, etc. It also is recommended for the construction of water meters and underground equipment, because of its strength and its resistance to continual dampness, corrosive water, gases, and fumes. Sand castings have a tensile strength of 40,000 to 50,000 lb per sq in. Annealed, hot rolled, and hot forged, it has a tensile strength of 60,000 to 70,000 lb per sq in. It can be welded both by gas and the various electric welding methods.

The "Duronze III" alloy is recommended as a particularly hard and strong silicon bronze, with high corrosion resistance, low coefficient of friction, and high wear resistance. It is essentially a hot-forging alloy; a forging of this material has a tensile strength of approximately 90,000 lb per sq in., according to the manufacturer.

Uses recommended by the maker include pump rods, valve stems, valve seats, valve bodies, etc.

PRESSED STEEL MULTI-BLADE WHEELS *at Production Prices!*



Immediate Delivery for Oil Burners, Driers, Air Conditioning Units, Etc.

Whether you want one or one thousand multi-blade wheels, the American Blower Corporation will care for your needs quickly and inexpensively.

A wide variety of combinations and types of wheels—ranging from a three inch diameter wheel to nine inches in diameter, with standard and reverse hubs, for clockwise or counter clockwise operation, in single and double widths — are carried in stock for immediate delivery.

Over fifty years' experience, quantity production methods and the finest equipment for the manufacture of multi-blade wheels for air handling enables us to produce these precision made wheels at unusually attractive prices.

Manufacturers are invited to correspond with us regarding wheels for oil burners, air conditioning units, driers, etc. There is no obligation. Address your inquiry to—*Appliance Accessory Department.*

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VENTILATING, HEATING, AIR CONDITIONING, DRYING, MECHANICAL DRAFT

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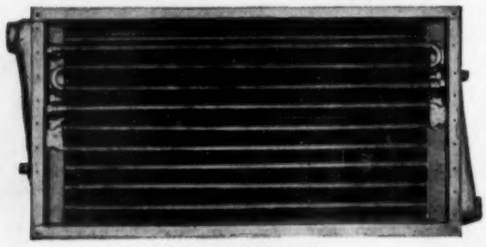
AEROFIN

Fan Blast Heat Surface

Installed Throughout



Universal Aerofin

AEROFIN, the original, modern, scientific Fan System Heat Surface, was chosen by Architects, Graham, Anderson, Probst & White, for Chicago's great new Post Office Building and installed under the general contract of John Griffiths & Son Company by H. P. Reger & Company, heating contractors.

AEROFIN won out again, as in hundreds of installations, because of superior design and workmanship and for its exclusive features.

Whatever you've wished for in a Fan System Heat Surface, you'll find in AEROFIN. Send for catalogue to the address below.

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Grants License Under Air-Conditioning Control Patent

Lewis Air Conditioners, Inc., Minneapolis, Minn., has announced that it has granted the Detroit Lubricator Company, Detroit, Mich., license under Patent No. 1,785,741, entitled "Air Conditioning Systems."

This patent contains broad claims relating to any air-conditioning system or circuit wherein a humidity regulator is rendered operative by a thermally-actuated regulator only when the heating medium has attained a temperature adequate for efficiently evaporating moisture and/or otherwise conditioning the air, says the announcement. The said patent in some of its claims further relates to any air-conditioning system where a fan is used for causing air to travel through air conditioning means and where the operation of the fan is controlled by the thermally-actuated regulator and rendered operative only when the medium affecting said regulator has attained a predetermined temperature.

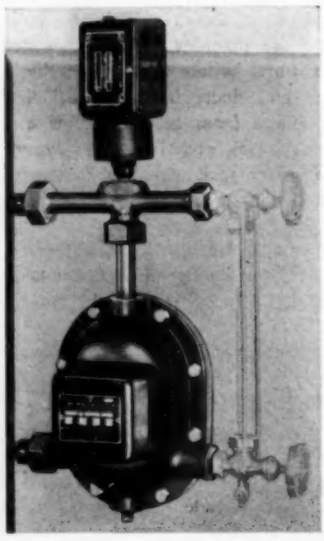
The said patent covers the hook-up, circuit or system of devices cooperating in the manner set forth in the claims without regard to the specific construction of the individual pieces of mechanism used in that system.

It is pointed out by Detroit Lubricator Company that the purchase of temperature and humidity controls manufactured and sold by it automatically carries with it a license to use such controls in the system covered by the above-mentioned patent.

Offers Low-Water Cutoff, Water Feeder

Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., has announced a new, improved bellows-sealed, packless construction low-water cutoff, duplex switch and water feeder for steam boilers which is designed for gage-glass mounting to make installation simple and inexpensive.

Two ways of providing protection against low water are offered by these controls. First, the fire may be shut down and remain so until the boiler is manually refilled. This is accomplished with the low-water cutoff which is connected into the electric circuit so that if a low water condition occurs a mercury switch cuts off all power. Second, the fire may be shut down and simultaneously an automatic water valve will open to allow refilling of the boiler. The low-water cutoff and silent solenoid valve supply this automatic safety control. If the water feeder valve is not used, the connections provided for it may be used to operate an alarm bell. The water feeder valve is installed directly in the cold-water inlet to make it free from liming and sediment collection troubles.



To further simplify installation and reduce cost the steam or vapor-pressure control or vacuum control may be screwed into the built-in sylphon on the top of the low-water cutoff, making it a duplex switch. This combination provides high-limit control and automatic shutdown in case of low water. The water feeder may also be used with the duplex switch as described above for use with the low-water cutoff.

The low-water cutoff and duplex switch are now available for any pressure or vacuum up to 25 lb.

Quality for 42 years!

While codes are the talk of the day, Wagner calls attention to its own Code of Quality under which it has operated for 42 years.

Wagner's code of QUALITY was adopted at the time the company was founded—long ago, in 1891. And never has Wagner swerved from its policy of building motors of only the highest quality . . . motors giving continuous, dependable power . . . motors not built to sell at a price, but designed and constructed to give maximum service at minimum cost.

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

MOTORS - TRANSFORMERS - FANS - BRAKES

S-533-3A

These Type HSV Fans are Ideal for Direct Motor Drive

Inlet view of large HSV Fan, and HSV Fan Wheel.

FOR air conditioning, ventilation and similar applications, if you're figuring on direct motor drive, Clarage Type HSV Fans offer several unquestionable advantages.

1. Higher operating speeds, especially in the smaller sizes, making possible the use of high speed, low cost motors.

2. Full Self-limiting Horsepower Characteristic protecting against overload, and thus permitting the use of the smallest possible motor in any given case.

3. Higher mechanical efficiencies over wide operating range.

4. Quiet operation despite higher speeds.

HSV Fans are built in sizes to meet all capacity requirements. Write for complete information.

CLARAGE FAN COMPANY, Kalamazoo, Michigan.

CLARAGE

Air Handling and Conditioning Equipment

Streamlines PAY!

There is no longer any excuse for cutting—fitting—trimming—patching. The modern welding fitting has wiped out these tedious operations and the uncertainties that go with them.

Contrast the "home made" branch outlet (above) with the result obtained by the use of a welding Tee. The cut-fit-patch way means sharp corners, protruding welds, ragged pipe interiors, inconsistent welding, weak points, and high frictional resistance.

The modern way means contours and sweeps, smooth unrestricted interiors, simple uniform roundabout V-butt welds, and lowest possible frictional resistance.

If the fittings are Taylor Forge Fittings these advantages are heightened by *added* reinforcement where stress is greatest, tangents that remove the weld from the zone of stress, and machine tool bevels that enable the welder to do a better job in less time.

Add to this the unchallenged security of a seamless forging, and you have the reason for the ever-growing popularity of Taylor Forge Tees, Weldells, Reducing Nipples, Welding Caps and Welding Neck Flanges. The better way costs no more. Ask for data.

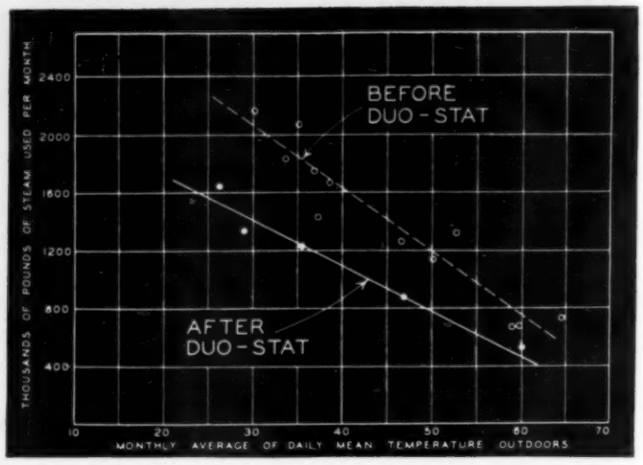
Also made from BYERS GENUINE WROUGHT IRON PIPE

TAYLOR FORGE & PIPE WORKS, CHICAGO
P. O. Box 485 50 Church Street, New York

TAYLOR FORGE

SEAMLESS STEEL FITTINGS FOR WELDING

Another PROOF



..that the DUO-STAT DOES *save steam*

Could any evidence be more conclusive than that presented in the graph above? By plotting the steam consumption against the average temperature *before* the Duo-Stat was installed and *after* it was installed, you can see at a glance just what savings were made.

This chart, showing Duo-Stat performance in the Madison-La Salle Building, Chicago, is merely typical of many similar charts which form a great mass of evidence for the Raymond Duo-Stat. More important than the individual records is the *consistent* saving that they show — savings that enables us to predict what Duo-Stat control can accomplish for you with ever-increasing accuracy.

Ask for a set of these interesting charts—or, better still, tell us your steam or fuel consumption by months for the last year so that we can prepare an accurate picture of your future steam costs with and without Duo-Stat.

F. I. RAYMOND CO.
629 W. Washington Blvd.
CHICAGO

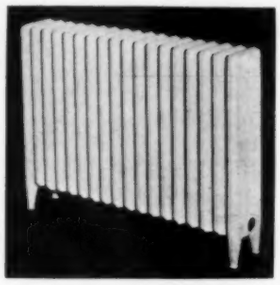
The DUO-STAT *alone combines these features* ●

- Controls room temperature by a combination of outside and radiator temperature. (A fully protected principle.)
- Is just as effective with one-pipe system as two-pipe system.
- Accomplishes partial filling of radiators in either a one-pipe or two-pipe system.
- Cannot be upset by open windows.
- Gives a modulated control that can only be described as Duo-Stat modulation.

RAYMOND DUO-STAT

New Cast-Iron Radiator Available

A new "Geddes" type cast-iron radiator is now available from Fowler & Wolfe Radiator Co., Norristown, Pa. According to a bulletin recently issued containing a description of its features and specification data, it has a minimum water or steam content per square foot of radiation surface. It is made in 20- and 26-in.

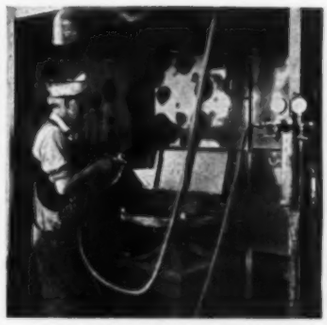


heights with a width of 4 1/8 in., lends itself readily to recessing. The radiator is not built to heat by convection; all of the surface (except the feet) comprises steam- or water-backed surface.

The specification table lists radiators with the number of sections ranging from 2 to 40, lengths 3 to 60 in.; heating surface for the 20-in. height ranges from 3.6 to 72.0 sq ft; for the 26-in. height, 4.8 to 96 sq ft respectively.

[From page 557]

2. The reduction in steam used will be greater during mild weather than during severe weather.
3. The reduction increases as the ratio of the non-working-hour period to the working-hour period increases.
4. The reduction will be less in a building equipped with a two-pipe vacuum return line system than in a building equipped with the old style Paul system.
5. More satisfactory temperature will be maintained by master control than with no control.
6. Heat loss from excessive ventilation through open windows will be reduced by zone control.
7. Defective design in the heating system becomes more apparent when operating with master control and the defects must be remedied before satisfactory results can be obtained.
8. The system of heat regulation maintaining lower temperatures during the non-working hour period will show a greater reduction in steam consumption than one which maintains the same temperature day and night.
9. If the non-working-hour temperature is too low, the rooms will not be comfortable at the beginning of the working-hour period even though the air temperature reaches 70 F.
10. The controlling thermostat should be located in a room where the radiators are not regulated by hand, and where it is not affected by open windows. A corridor away from outside doors may be the best location.
11. The relation of night and day temperature is very important and cannot be kept constant during all weather conditions. During moderate weather a night temperature of 60 F may be satisfactory, while during extremely cold weather it would be impossible to bring the temperature up within a reasonable time in the morning. The design of the heating system and the consideration of economy will determine the proper spread between night and day temperature.



Trouble Starts in Unfiltered PIPE LINES

A Protectomotor Air Filter on the compressor makes it run 3 to 5 times longer before overhauling is needed. But it is not sufficient protection for tools at the other end of line. There is always some oil, water, scale, rust and grit in compressed air lines, to play havoc with the tools and spoil costly work.

Therefore, every pipe line should have a separate Protectomotor Pipe Line Air Filter to remove all foreign matter from the compressed air. This filter insures delivery of dry air that is 99-9/10% clean, for paint spraying, cleaning operations, agitating liquids, making ice, chemical process, and the like. It also increases the life of compressed air tools, reduces maintenance costs and increases their efficiency.

The Protectomotor is a dry filter and is easy to clean.

Write for catalog and particulars regarding our 30-day free trial offer.

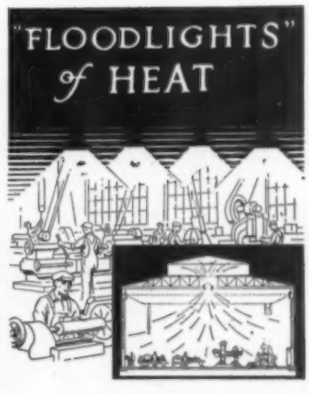
Staynew Filter Corp.
13 Leighton Ave., Rochester, N Y.

PROTECTOMOTOR
REG. U.S. PAT. OFF.
99 9/10 Per Cent EFFICIENT
AIR FILTERS

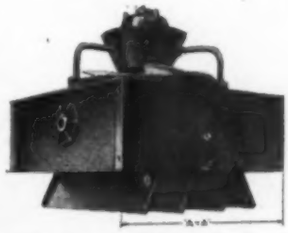
We Realize That You HAD To Put Off That Heating Job . . .

EVERYWHERE, newly re-opened plants are facing cold weather with obsolete or inadequate heating equipment. Plant engineers have been compelled to defer the installation of modern heating equipment until managements could be sure that better times were really here.

So, quick action is now necessary and we want you to know that you can obtain Wing Featherweight Unit Heaters as quickly as you can types that do not possess the same advantages.



WING "FEATHERWEIGHT" UNIT HEATER
Is a Floodlight of Heat Not a Spotlight



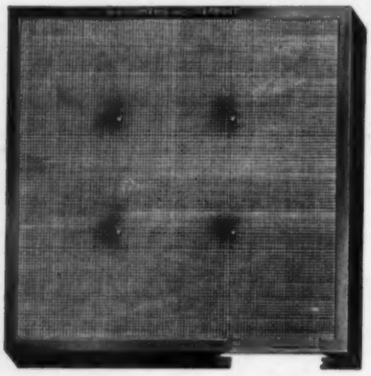
L. J. WING MFG. COMPANY
14th St. and 7th Ave. New York, N. Y.
Specialists in Air Handling Equipment since 1878

A PERMANENT GLASS AIR FILTER

"Hair Glass" is a special type of spun glass differing from any other filtering material now on the market.

The Somers "Hair Glass Filter" is not affected in the slightest by water or by a great many chemicals. It may be used dry and washed clean each time it fills up with dust, or it may be used in connection with a water spray for both continuous filtering and humidifying the air. It is a permanent installation.

The Somers filter is not impregnated with oil or adhesive —the matting of the individual fibers makes this unnecessary.



Each strand of annealed "Hair Glass" is held solidly in place so that no amount of vibration can produce thin spots in the filtering surface.

If you want economy in air filtration, Use the Somers Filter. Send for data sheet and prices.

SOMERS AIR FILTER SALES CO.
7310 Woodward Ave. Detroit, Mich.

Always marked with the "Diamond"

Jenkins
BRONZE IRON STEEL
VALVES
Since 1864

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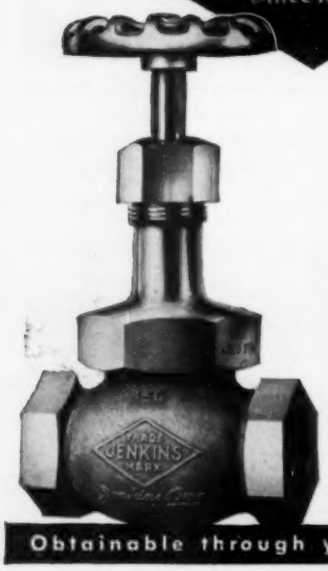

THERE is QUALITY in Fig. 106-A Jenkins Bronze Globe Valve—extra deep stuffing box—slip-on, stay-on disc holder — one-piece screw-over bonnet—Jenkins disc. It pays to insist on Jenkins Valves and the extra service that has characterized Jenkins quality since 1864.

JENKINS BROS.
80 White Street, New York, N. Y.
Bridgeport, Conn. Boston, Mass.
Chicago, Ill. Philadelphia, Pa.

Fig. 106-A Globe, Screwed

Obtainable through your supply house

(From page 564)

valve, the trap is allowed to discharge to atmosphere, and action and tightness of trap valve can quickly and easily be seen. This arrangement is particularly useful where several units are discharging condensate into one return line, as thereby a leaky or defective trap can readily be detected.

One more valve is shown—a check valve on the outlet of the trap to prevent condensation from other operating units backing up and filling a unit which is shut down

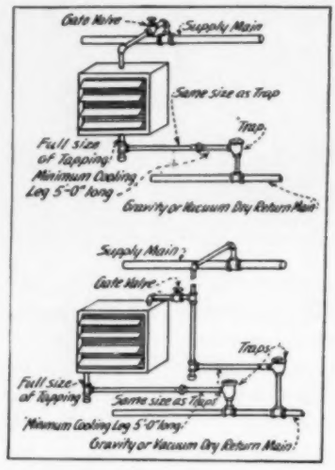

Fig. 9 — (Above) Unit heater connections for two-pipe gravity or vacuum system as given by one manufacturer. (Below) Connections for two-pipe gravity or vacuum system with supply branch dripped through trap

and on which the operator has failed to close the outlet stop valve. Unions close to inlet and outlet of trap facilitate easy and quick removal of trap for repairs. Carrying a spare trap to install in place of a trap requiring repairing eliminates a long shut-down of the unit.

It is suggested by T. H. Rea[1] that the bypass valve be above the trap and furthermore that there be two unions in the bypass to make it easy to take the trap out for inspection or whatever repairs may be necessary. Adoption of standard trap connections (either with or without bypass) in a plant not only facilitates trap inspection but makes it possible to put a replacement trap on the line in a few moments. Referring to Fig. 10, he points out that it would have been better practice to install both traps below the bypasses to prevent loss of prime in case a leaky bypass developed.

[In addition to the foot-note references, acknowledgement for information contained in this article is also made to Illinois Engineering Company, Justus Steam Trap Company, Sarco Company, Inc., and Warren Webster & Company.]

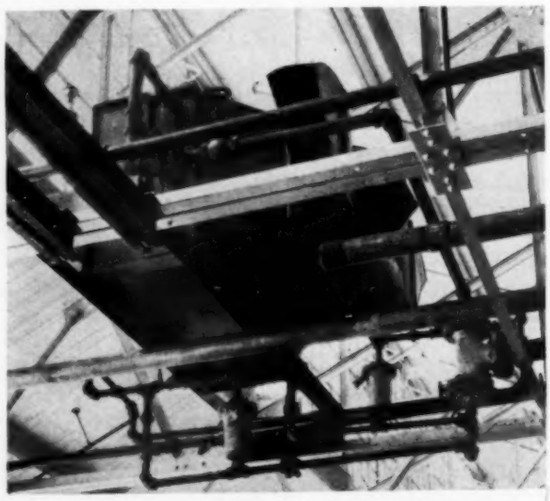

Fig. 10—Traps draining heater and supply line

A FOUR-POINT PRESENTATION

In the Leland flexible base motor for oil burner, stoker and air conditioner drive four characteristics stand out like beacons in the night.

1. QUIETNESS IN OPERATION—all motor noise confined to the motor frame—none transmitted through to the motor base or end bell mounting.

2. FREEDOM FROM VIBRATION—Leland motors are constructed in inherent balance and operate with remarkable smoothness.

3. POSITIVE ALIGNMENT—no misalignment of the motor shaft with respect to the motor base due to excessive weight, abnormal belt pull or any of the various forms of thrust—of particular importance to buyers of motors for direct connection of drives.

4. CAPACITY AND STURDINESS—Leland resiliently mounted motors handle heavy starting loads, carry temporary overloads or withstand stalled loads without distortions or distress.

Open and totally enclosed designs
Auxiliary fan cooling when necessary
Special designs where required
Ratings 1/8 to 3 h. p.

For more complete information, write

The LELAND ELECTRIC Co.
DAYTON · OHIO · U·S·A

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KONTAX MERCURY TUBES
Leland Motors
MERCURY TUBE CONTROLS

Clean Air *is not a* Luxury

In modern buildings clean air is not a luxury—it is an asset. The tremendously increased interest in air conditioning indicates that within a very few years NO building will be modern without it. Because Buffalo Air Washers supply CLEAN, properly tempered air 365 days a year, at a very moderate operating cost, because they operate for a lifetime—because they are already in use in almost every type of structure in every branch of Industry, they merit your first consideration when you think of air-conditioning apparatus. Before you purchase or specify any air cleaning equipment—get all the facts about

"Buffalo" AIR WASHERS

The illustration shows a Buffalo Non-Clogging Spray Nozzle of the type used in Buffalo Air Washers. In addition to this service, Buffalo Spray Nozzles are commonly used for many industrial purposes. They (1) give an exceedingly fine spray on pressures as low as 15 lbs., (2) have removable cap which can be renewed if liquid handled is corrosive, (3) can be made of any material, (4) are non-clogging and (5) are made in complete line of sizes, from ¼ inch to 2½ inch pipe size.

Write for bulletins on Spray Nozzles or Air Washers to Buffalo Forge Co., 171 Mortimer St., Buffalo, N. Y., in Canada, Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" SPRAY NOZZLES

HERE
is the inside of the new B & J Trap

—the greatest advancement in trap design and construction in many years. The cage contains the thermostatic member, carries its own seat and is a complete operating unit in itself. Easily and quickly replaced without special tools. —lift out the old unit and drop the new one in. Write today for illustrated Bulletin.

BARNES & JONES *Inc. 128 Brookside Ave.*
JAMAICA PLAIN, MASS.

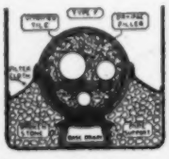
Ric-wiL Cast Iron Conduit, Type F, with heavy duty tile Base Drain.

RIC-WIL Cast Iron

Conduit provides permanent protection, without added construction, for underground steam pipes subjected to extreme load or vibration.

DRY-PAC Insulation

is waterproofed, thus keeping steam pipes dry and maintaining the highest thermal efficiency. Write for complete details.



Tile Ric-wiL, Type F, with three pipes.

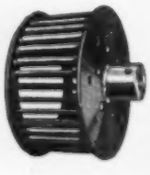
THE RIC-WIL COMPANY
1562 Union Trust Building • • • • • Cleveland, Ohio
Branches: New York, Chicago, San Francisco
AGENTS IN PRINCIPAL CITIES
REG. U. S. PAT. OFF.
RIC-WIL
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

NOISE

● This is a device for preventing NOISE made by steam passing through a pressure reducing valve. No moving parts.

Send for Bulletin

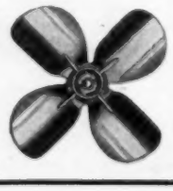
BOYLSTON STEAM SPECIALTY COMPANY
126 WEST ILLINOIS STREET, CHICAGO, ILLINOIS



TORRINGTON
FANS AND BLOWER WHEELS

Patented All Aluminum Multiblade, Balanced Blower Wheels. Unexcelled for quiet and smooth operation.

30 years' experience building Propeller Fans, assembled, balanced and tested, ready to mount on motor shaft.



THE TORRINGTON MFG. CO.
44 FRANKLIN ST.
TORRINGTON, CONN.

Steam Generation in Boilers

I WOULD like to have a clearer conception of just what occurs in a steam boiler when a vapor system (non-mechanical vacuum system) is operating at sub-atmospheric pressure.

Will there not be an entirely different performance in a boiler burning solid fuel than in one burning a fluid fuel? In one, will the incandescent fuel continue to give up heat although the drafts have been closed? In the other, will not all heat transfer stop immediately the gas or oil is cut off?

In the solid-fuel-burning boiler will steam be generated at sub-atmospheric pressure as long as the furnace temperature is above the boiler-water temperature and no equilibrium be established between boiler water temperatures and corresponding absolute pressure because the condensing steam, reducing the pressure below atmosphere, is condensed extraneous of the boiler, i. e. in radiators and piping?

In the fluid-fuel-burning boiler will there be no generation of steam when the fuel is cut off or will there be generation of steam as the pressure recedes, the latent heat of evaporation being taken from the boiler water?—M. J. B.

Answer: The operation of any vapor system depends upon the fact that the boiling temperature of water is affected by the pressure existing over the surface of the water. At any time a vapor system is put into operation, the boiler pressure must be brought above atmospheric pressure to force out any air in the system. After the air is forced out and the source of heat to the boiler is cut off, the steam in the radiating surfaces continues to condense, and since there is no air to replace the volume of the condensed steam, the pressure within the system will fall below that of the atmosphere. The intensity of the vacuum formed depends to a great extent upon the tightness of the piping system.

As the pressure falls, the boiling point of the water also falls, and since the temperature of the water in the boiler is above the boiling temperature, vapor (steam) at a temperature corresponding to the existing pressure will be given off. The latent heat required to form the vapor (steam) will be taken from the body of water in the boiler, thereby lowering the temperature of this body of water. This process continues until finally the temperature of the water in the boiler corresponds to the lowest pressure (highest vacuum) that the system is able to maintain. After this time, no more vapor (steam) will be given off unless heat is supplied from an outside source.

This process is the same regardless of what sort of fuel is used in the boiler. Of course with the use of solid fuel a considerable amount of heat from the hot unburned fuel will be given off after the dampers are closed. With a liquid or gaseous fuel, the supply of heat is cut off immediately the combustion is stopped. There will be, however, some stored heat from any refractories which may be present.

There will be a transfer of heat to the water from the boiler heat-transferring surfaces as long as these surfaces are warmer than the water.—SAMUEL R. LEWIS*.

Directory of Industrial Research Laboratories

"Industrial Research Laboratories of the United States (Including Consulting Research Laboratories)" is the title of Bulletin 91 which has recently been published by *The National Research Council,* Washington, D. C. It is a paper-bound book of 223 pages, 6½x9¾, price $2.00. This is the fifth edition of the Council's directory of industrial research work, and was compiled by Clarence J. West and Callie Hull.

The contents include the introduction, the list of laboratories, geographical distribution of laboratories, and a subject classification of laboratory activities. In this listing, it is indicated that work on acoustics is being done in 20 industrial research labora-

*Consulting Engineer, Chicago, Ill., and Member of Board of Consulting and Contributing Editors.

tories; air conditioning, 29 laboratories; air flow, 4; belting, 3; building materials, 32; calorimetry, 1; coking of coal, 27; preparation of coal, 7; combustion, 43; cork, 4; corrosion, 82; drying equipment, 9; dust removal, 4; electric heaters, 4; electric motors, 17; evaporation, 24; flow meters, 10; fuel utilization, 54; fuels, 29; heat, 34; heat transfer, 11; heating, 49; high-pressure apparatus and methods, 1; humidity control, 2; industrial hygiene, 5; recording instruments, 37; sound insulation, 9; thermal insulation, 34; pumps, 7; vacuum pumps, 6; radiators, 3; refrigeration, 32; soot blowers, 1; sound, 32; temperature control, 30; thermometers and thermometry, 5; ventilation, 6; autogenous, gas, electric and thermit welding, 47; X-rays, 6.

The information given in the list of laboratories includes the company name and address, the personnel engaged in the work, and a brief outline of the research.

Pamphlet Covers Protection from Chromium and Its Compounds

The Policyholders Service Bureau of the Metropolitan Life Insurance Company, 1 Madison Ave., New York City, has issued a 16-page illustrated pamphlet entitled "Protection of Workers Exposed to Chromium and Its Compounds." According to the introduction "the increasingly diverse and numerous applications of chromium and its compounds have renewed the interest in the troublesome, although not serious, effects of the action on the skin of exposed workers." Toxicity, uses, modes of contact, effects on workers, and preventive measures are considered. A bibliography also is included.

In the section on preventive measures, and under the heading "plant hygiene," it is recommended that all operations involving the use of chromium compounds be localized in departments completely separated from other departments in the plant; strict cleanliness of work places, floors, apparatus, and tools is stated to be an important feature of preventive work.

Efficient local exhaust ventilation, as near as possible to the source of the hazard, is essential, it is stated. Two methods of utilizing such ventilation are briefly described. It is also stated that the material should be handled mechanically rather than by hand. Chromate in solution may be delivered from the vats to the tanks through pipe lines operated by a pump. It also is mentioned that workers should be prohibited from continuing operations if the ventilating system is shut down.

Conventions and Expositions

National Association of Practical Refrigerating Engineers: Annual convention and educational exhibition, November 8-11, Roosevelt Hotel, New Orleans, La. National Secretary, Edward H. Fox, 435 N. Waller Ave., Chicago.

American Society of Mechanical Engineers: Annual meeting, December 4-8, New York City; headquarters, 29 W. 39th St. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

American Society of Refrigerating Engineers: Annual meeting, December 6-8, Hotel New Yorker, New York City. Secretary, David L. Fiske, 37 W. 39th St., New York.

Joint Meeting, Air Conditioning in Industry: Popular forum on air conditioning sponsored by *A.S.M.E.* and *A.S.R.E.* during meetings of the Societies in New York, first week in December.

American Society of Heating and Ventilating Engineers: Annual meeting, February 5-8, New York City, Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

International Heating and Ventilating Exposition: Third exposition, February 5-9, 1933, Grand Central Palace, New York City. Charles F. Roth, Manager, International Exposition Co., Grand Central Palace, New York City.

American Oil Burner Association: Annual meeting and oil burner show, Philadelphia, Pa. (Dates to be announced.) Secretary, Harry F. Tapp, 342 Madison Ave., New York City.

IMMUNE to CORROSION

DART UNIONS with their TWO BRONZE SEATS protect the joint from corrosion; have a ball seat properly ground. Heavy pattern malleable iron pipe ends and nut for strength. A sample for your trial is waiting.

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Sales Agents
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Canadian Factory
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DART UNIONS

Statement of Ownership and Management of "Heating, Piping and Air Conditioning" for October 1, 1933

The following is a statement of ownership, management, etc., as required by the Act of Congress of August 24, 1912, of "Heating, Piping and Air Conditioning," published monthly at Chicago, Illinois, for October 1, 1933:

State of Illinois, County of Cook, ss: Before me, a Notary Public in and for the State and county aforesaid, personally appeared D. J. Hansen, who, having been duly sworn according to law, deposes and says that he is the manager of "Heating, Piping and Air Conditioning," and that the following is, to the best of his knowledge and belief, a true statement of the ownership and management of the aforesaid publication, for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:
Publisher, Engineering Publications, Inc., Chicago, Illinois.
Editor, F. P. Keeney, Chicago, Illinois.
Managing Editor, C. E. Price, Chicago, Illinois.
Business Manager, D. J. Hansen, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Engineering Publications, Inc., 1900 Prairie Avenue, Chicago, Illinois. Stockholders: F. P. Keeney, Chicago; O. T. Carson, Chicago; E. D. Winslow, New York City, N. Y.; R. Herlov, Chicago; C. L. Davis, Chicago; E. G. Hutchison, Chicago; R. Payne Wettstein, Pittsburgh, Pa.; W. J. Osborn, Fairfield, Conn.; D. M. Kenney, Chicago; D. J. Hansen, Chicago.

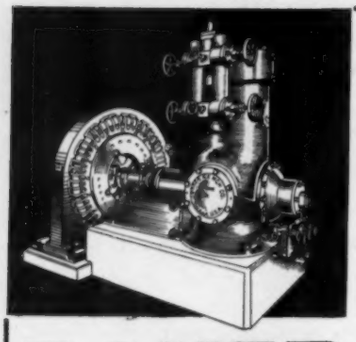
3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

D. J. Hansen,
Manager.

Sworn to and subscribed before me this 4th day of October, 1933.
[My commission expires Sept. 14, 1934.]
(SEAL)

L. M. Dixon,
Notary Public.



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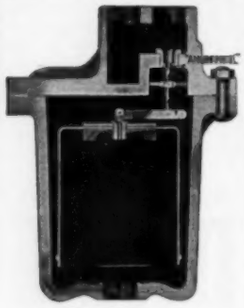

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French Author Studies Ventilation

A work which is said to be one of the first in French technical literature to consider ventilation from the scientific and medical viewpoints is "Etude Physiologique et Technique de la Ventilation," by F. A. Missenard, a 185-page paper-bound volume.

The first part consists of a study of heat and moisture loss from the human body to the ambient air, based largely on data reported by the research laboratory of the *A. S. H. V. E.* and on English, German, and French works. The author uses these researches to disprove the old "crowd poisoning" theory of ventilation. The second part of the book studies the physical and biological impurities of the air, particularly the origin and development of bacteria; the laws of transmission of contagious diseases by air are discussed.

The third section considers the requirements of a ventilating installation, and the circulation of air in rooms and buildings, air filters, air washers, humidity, etc. In an appendix, results of the author's studies on effective temperature and "resulting temperature" are given, including consideration of wall temperatures.

Recent Trade Literature

Agitators: The Patterson Foundry & Machine Company, East Liverpool, Ohio. 4-page pamphlet describing uni-power self-contained agitators for process tanks, vats, etc.

Alloys: Bridgeport Brass Company, Bridgeport, Conn. 24-page booklet describing three types of high strength silicon bronzes and discussing their uses.

Belt Drives: F. L. Smidth & Co., 225 Broadway, New York City. Loose-leaf bulletin on short-center flat-belt drives for compressors, fans, pumps, etc., and various process machinery in different industries.

Boilers: Paul Wright & Company, Birmingham, Ala. 32-page booklet of design information and dimensioned drawings for high-pressure boilers. Detailed information on selection, installation, etc., is given.

Boilers: The Titusville Iron Works Company, Titusville, Pa. 4-page bulletin covering line of high-pressure boilers for industrial uses where small quantities of high-pressure steam are required. They are for mechanical firing, although two types can be equipped with grates for hand firing. Complete engineering data are given.

Convectors: Commodore Heaters Corporation, 11 W. 42nd St., New York City. 4-page bulletin of list prices for Convectofin built-in heaters; drawings of seven typical installations and tables of effective heating capacities are also given.

Fans: International Engineering, Inc., Dayton, Ohio. 8-page catalog of propeller-type fans, giving dimensions, capacities, prices, etc. Several different types, including silent, extended-shaft, and multi-blade, are included. Housings and supports are of all aluminum or of all steel, hot galvanized construction. Pent houses, shutters, guards, and panels are also illustrated and described.

Forced-Draft Control: The Henry Furnace & Foundry Co. (Miles Furnace Fan Division), 3471 E. 49th St., Cleveland, Ohio. 4 page bulletin describing controlled forced draft for reducing costs, maintaining uniform steam pressure and temperature, and increasing efficiency.

Indicator Valves: Bacharach Industrial Instrument Company, 7000 Bennett St., Pittsburgh, Pa. 4-page leaflet describing a new indicator valve for diesel engines.

Refrigeration Compressors: Worthington Pump and Machinery Corporation, Harrison, N. J. 16-page bulletin containing many illustrations and complete descriptions of compressors equipped with feather valves, for refrigeration; types shown include vertical, horizontal, steam-driven, diesel-and-gas-engine driven, and CO_2 compressors.

Refrigerating Units: Frick Company, Waynesboro, Pa. 12-page bulletin giving complete information on low-pressure

refrigerating units in more than twenty types and sizes, with motors ranging from ¼ hp up. A section is devoted to equipment for air conditioning.

Steam Traps: The Strong, Carlisle & Hammond Co., 1392 W. Third St., Cleveland, Ohio. 8 page bulletin on open and inverted bucket steam traps—semi-steel, cast and forged steel. The features of the several types are described and capacity and installation data are given. Features discussed include wear-proof parts, improved seat design, anti-balancing device, thermal air valve, etc.

Stokers: Detroit Stoker Company, General Motors Bldg., Detroit, Mich. 12-page bulletin on multiple-retort stokers showing illustrations and giving description of this heavy-duty stoker. Also 16-page bulletin on double retort, side-cleaning stoker showing several applications, especially to boilers already installed where no basement is provided for ash removal.

Thermometers and Pressure Gages: The Brown Instrument Company, Philadelphia, Pa. 80-page catalog, carefully illustrated, of thermometers, pressure and vacuum gages, liquid-level gages, hygrometers and accessories—indicating, recording, and controlling. The features of the various instruments are described in detail; a section of the catalog is devoted to the uses of such instruments in different industries. Also, a folder on the subject of saving dollars by analyzing chart records, and describing several types of instruments and recorders.

Thermostatic Traps: Barnes & Jones, Incorporated, 128 Brookside Ave., Jamaica Plain, Mass. 4-page bulletin describing a new return trap using a thermostatic element, contained in a cage, illustrating their testing, and giving dimensions and capacities.

Valves: The Edward Valve & Manufacturing Co., Inc., 1200 W. 145th St., East Chicago, Ind. 28-page catalog section on high-strength iron valves—non-return, globe and angle, check, and blow-off for steam service up to 250 lb. Descriptions, specifications, dimensions, and list prices are given.

Warm-Air Heating: Brown Sheet Iron & Steel Co., 964 Berry Ave., St. Paul, Minn. 6-page bulletin and mimeographed bulletins on the Brunett heat utilizer and warm-air furnaces. The features are described, specifications are given, and various installations are referred to.

Water Heaters: Westinghouse Electric & Manufacturing Co., Mansfield Works, Mansfield, Ohio. 16-page catalog devoted to electric water heaters (storage tank heaters, strap-on heaters, and heaters of side-arm circulation and immersion types) for use in commercial-type buildings and residences. Complete information and many illustrations are included.

Welding Equipment (Pressure Regulation): Air Reduction Sales Co., 60 E. 42nd St., New York City. Folder on automatically-maintained pressure regulation for oxy-acetylene welding. New two-stage reduction oxygen and acetylene regulators are described and completely illustrated; their advantages in eliminating need for readjusting regulators to compensate for drop in cylinder pressure are discussed.

Welding Fittings: Tube-Turns, Incorporated, Box 987, Louisville, Ky. 24-page price list and engineering data bulletin covering "Tube-Turns," welding tees, welding neck flanges, welding nipples and flanges, slip-on flanges, threaded companion flanges, blind flanges, welding heads, welding reducers, and shaped welding nipples. The data section of five pages contains useful information.

Welding Wrought Iron: A. M. Byers Company, Pittsburgh, Pa. 8-page service bulletin on the subject of welding of genuine wrought iron, giving information for the welder, fabricator, and designing engineer. Several installations are illustrated, and a complete table of sizes of welding fittings available in wrought iron is included.

Zinc: The New Jersey Zinc Company, 160 Front St., New York City. Reprint of article from *Public Health Reports* on zinc in relation to general and industrial hygiene.

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